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FOR MANAGEMENT

APRIL 1959

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INTERNATIONAL PETROLEUM EXPOSITION GUIDE BOOK

. . . All the information you need to plan your trip to the Tulsa Oil Show.

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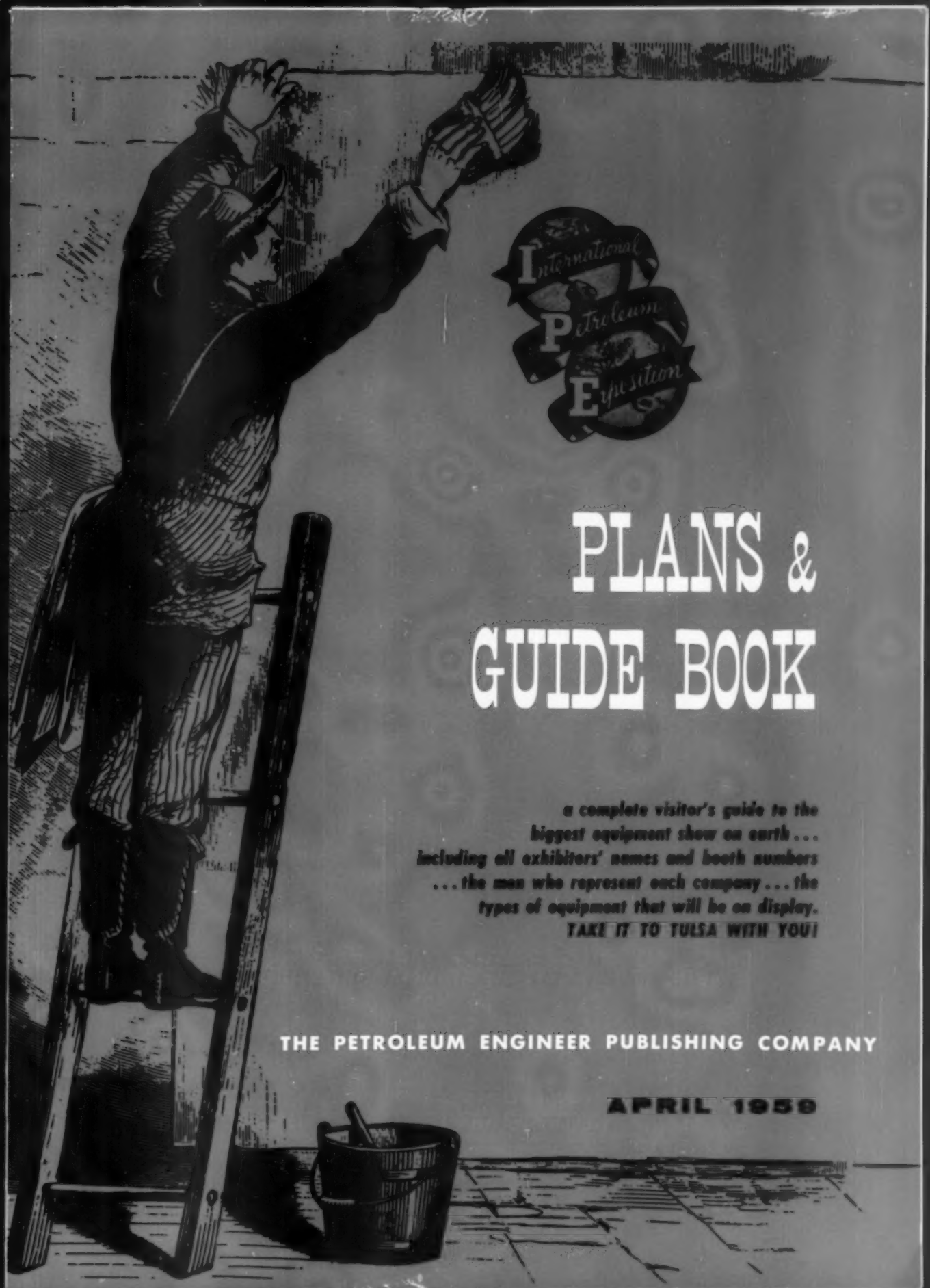

PLANS & GUIDE BOOK

a complete visitor's guide to the biggest equipment show on earth . . . including all exhibitors' names and booth numbers . . . the men who represent each company . . . the types of equipment that will be on display.
TAKE IT TO TULSA WITH YOU!

THE PETROLEUM ENGINEER PUBLISHING COMPANY

APRIL 1959

IPE PLANS AND GUIDE BOOK SECTION

published for your convenience by
THE PETROLEUM ENGINEER PUBLISHING COMPANY
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INTERNATIONAL PETROLEUM EXPOSITION

. . . WHAT IS IT?

WHAT IS IPE?

It's many things: The biggest single event of a nationwide observance of the 100th anniversary of oil. . . the showcase of the industry . . . international meeting place for the petroleum fraternity . . . largest exposition of oil country equipment, products and services . . . a half-billion dollar investment spread over 30 acres for public appraisal . . . parades, awards, entertainment . . .

For most oil men, the 14th IPE at Tulsa will mark the crest of individual observance of oil's centennial. It will be, too, a few days respite for the average individual in this business to step back and "look at the forest, rather than the trees." The forest at IPE, may be the many new drilling rigs set up on the grounds, revolutionary production equipment on exhibition, pipeline construction equipment, or

1953 Petroleum Exposition, the most recent Tulsa oil show, boasted attendance of 450,000. All indications suggest that the number of 1959 registrants may exceed that of 1953 by as many as 100,000.

Steering IPE . . .

W. K. Warren
President

Wm. B. Way
General Manager

displays of automation equipment for refiners and transmission people.

This year's IPE, in fact, is the showplace for equipment and services exhibited by some 550 companies valued at $500,000,000.

New Equipment

The Tulsa Oil Show, as it was called in 1923 when it began, has traditionally been the "unveiling platform" for new products and tools. The 1959 show is certainly no exception. It has been estimated that at least 10 percent of the exhibitors will present entirely new equipment never before introduced. The list includes new ultra-deep drilling and servicing rigs, wireless perforators, glass fiber tanks, swivel packers, special pumps of several types, unique pipeline construction equipment.

Scores of manufacturers are introducing new lines of equipment and new models of existing equipment.

Scattered throughout the grounds, and all under roof, hundreds of exhibits are being installed representing every phase of the oil industry — exploration, production, pipeline, refining and petrochemical.

The Hall of Science, being prepared by a committee of the industry's scientists, will display the most advanced developments that researchers have produced in recent years.

From all over the world will come representatives to observe and to learn.

More than 1500 representatives of foreign oil-producing nations are expected, and most of them will also attend the World Petroleum Congress in New York, which follows the Tulsa show.

Planning the Show

The planning that has preceded the show dates back over a year. Most of the exhibit space has been sold out since last summer. Hotel and motel space for the time around the date of the IPE has been void since the first of the year. Hundreds of workmen have been on the grounds for the last six months — so many that a restaurant had to be opened on the grounds in February.

Major facelifting of the grounds has been in progress for some time. In addition to the many huge permanent exhibit buildings, all of which have been reconditioned and repainted, individual exhibitors have actually torn down and uprooted structures in which they had invested more than $100,000 for the last Exposition, and are replacing them with new buildings that represent thousands of hours of architectural planning — and which will be the showcase for the equipment and displays that will be as modern as tomorrow's space ship. A million dollars has been spent in preparing the Exposition's own buildings for this year's show.

The industry is anxious, ready and waiting for the 1959 IPE.

The planning that has preceded the show has not been without direction. Steering the mammoth show to certain new records of attendance and size is General Manager William B. Way. The executive committee of IPE consists of: W. K. Warren, board chairman of Warren Petroleum, who is IPE president; Frank J. Hinderliter, Tulsa independent, IPE vice president; J. L. Shakely, president of Oklahoma-Mississippi Products Line, IPE treasurer; H. R. Powers, assistant general manager of Bethlehem Supply, is IPE secretary. Also on the executive committee is D. D. Bovaird, president of Bovaird Supply; E. F. Bullard, Tulsa independent; W. H. Helmerich II, president of Helmerich & Payne, Inc., and A. W. McKinney, president of National Supply.

Early Oil Shows

The first IPE, was not the unquestioned showcase for the industry as it is today, although through no fault of its forward-looking founders. The first show in 1923 was hardly international and might have been more correctly titled "Carnival" rather than "Exposition." Its humble beginning, at the insistence of the late Earl Sneed, was under the direction of business and oil equipment firms in the Tulsa area. The 1923 show had a carnival atmosphere with queen contests, midway and many different concessions in evidence. It was held on a few roped-off streets in the booming oil town's downtown area.

In the early years the show was held annually, but later, industry leaders decided to space the shows farther apart. By 1929 the Exposition had moved to its present site within the Tulsa State Fair Grounds and some of the permanent exhibit buildings had been constructed. "Mr. Oil Show"

IPE Executive Committee . . .

F. J. Hinderliter | J. L. Shakely | H. R. Powers | D. D. Bovaird | E. F. Bullard | W. H. Helmerich II | A. W. McKinney

since 1929 — William B. Way — says that somewhere around that year the show became a "serious display of oil equipment" and stopped all the carnival operations. It has remained that way since.

The 1929 oil show, which ran for eight days, registered some 126,000 people. Some 60 exhibitors were listed.

The 1930 exposition drew 151,000 people to see exhibits by 75 companies. The number for this particular show came primarily by train. The November 1930 issue of *The Petroleum Engineer* said: "A trusted indicator of the wide appeal of the oil show is the report on overflow Pullmans called into service. This report, as submitted by A. F. Winn, Skelly Oil Company, and chairman of the special trains committee, shows that from the great gathering point of St. Louis the number of these cars reaching 51, bringing the total for the U. S., Canada and Mexico to 145 special Pullmans. The regular coaches were found to have increased proportionately."

In that year IPE officials noted that there were representatives from 18 foreign countries.

The exhibits on the oil show grounds were then housed in the Texas, Oklahoma, California and Marketers & Refiners Building; the latter two added for the 1930 exposition.

During these years safety contests, pipelying contests, technical sessions, and open question-answer periods played an important part in the IPE schedule of events. Oil's Old Timers were honored, even in those days, and IPE had taken upon itself the task of sponsoring an Old Timers Home. Also in 1930, show officials were claiming for the IPE "an intrinsic value of $10,000,000 — stemming from the original valuation of $5000 in 1923."

Many "firsts" in the oil industry have been introduced at the IPE. Steel derricks, slim-hole drilling equipment, rotary drilling equipment, microwave applications and countless other innovations were first seen at the Tulsa Oil Show.

Several men have given freely of their time and energy to make IPE what it is today— the world's largest single-industry trade fair.

The original idea is generally credited to Earl Sneed. He, with the help of a few pioneers of the town, such as J. Burr Gibbons and William Holden, generated enough steam in Tulsa to make the oil show possible. The late W. G. Skelly was one of the original directors and was elected president in 1926. He held the post until his death in 1957.

Founders of IPE . . .

The Late
Earl Sneed

The late
W. G. Skelly

Growing, Growing, Grown

Since its original inception, the International Petroleum Exposition has enjoyed a generous growth pattern for each succeeding show. Even through the depression in the 1930's the number of exhibitors and the attendance figures were considerably higher each time an oil show was held. The 1953 Exposition had 450,000 in attendance and 1484 exhibitors; value of the displays has been estimated at $250,000,000.

Using these figures and the traditional growth pattern as a guide, general manager Way says he expects the 1959 show to display the newest and best of all types of oil equipment and services to over 500,000 persons and he estimates the value of these displays at $500,000,000.

1924 Tulsa Oil Show featured the finest in bullwheels and the new steel derricks, as well as rides for the kiddies, sideshows and attractions.

IPE AWAITS YOU

. . . the Red Carpet is out for 500,000 visitors

VISITORS to Tulsa for the 14th oil show will find the city geared almost entirely for their benefit. Tulsa is located almost in the geographical center of "oil country" and boasts the title of "Oil Capitol of the World." Normally a city of about 260,000, Tulsa officials expect the population to rise during the May 14 - 23 dates of oil's world fair to well over a half-million.

Information

The first sight to greet visitors in all of the major transportation terminals will be a huge "Welcome to Tulsa" sign. In near proximity to the sign oil men will find a booth with at least two pretty girls in attendance where almost any question about the city or the oil show will be answered. Also, the booth will contain a direct line telephone to the IPE housing bureau so that any last minute problems with housing can be solved.

Housing

Housing bureau manager, S. J. (Steve) Raphel, said that Tulsa citizens have responded so well to the call for housing that even the man who waits until arriving in Tulsa can secure adequate, comfortable accommodations. The housing bureau will remain open for 24 hours a day during the show.

The visitor arriving by automobile can call for accommodations direct to the housing bureau by dialing LUther 5-8118. The bureau is located in the Oil Capitol Building, 514 South Main.

Despite the greatly increased attendance expected this year over that of previous Expositions, Raphel says that accommodations will be provided for everyone. He points out that dozens of new motels have been erected in the Tulsa metropolitan area in recent years, including several that will open for business just prior to the oil show.

Tulsa residents have been most generous in making their homes available for occupancy by visitors. "We still have available," he said, "plenty of bedrooms in private homes on a day to day basis, as well as complete furnished homes on not less than a ten-day basis."

All hotel rooms in Tulsa have been assigned. Motels did not clear through the housing bureau but those facilities have all been reserved by individuals and companies. He said that resort lodges, such as Western Hills on Fort Gibson Lake, 50 miles from Tulsa, are still available.

Raphel made this emphatic statement: "We will be able to take care of everyone. Anyone wanting accommodation should address the IPE Housing Bureau, Oil Capitol Building, 507 South Main Street, Tulsa."

LUther 5-8118 will solve your housing problems. S. J. (Steve) Raphel, manager of the IPE Housing Bureau discusses one of the countless number of applications for housing accommodations with Anthony Keating, Keating Drilling Company, chairman of the housing committee. Raphel and Keating emphasized the fact that housing will be available for all who wish it.

Transportation

Transportation for those arriving by public carrier is no problem. There are two major taxicab companies in the city, Checker and Yellow. Their rates are standard and metered . . . 40 cents for the first one-half mile and 10 cents for each additional two-fifths mile with 10 cents per additional passenger. All taxis are limited to five persons. The two companies have in excess of 200 cabs operating in the Tulsa area. Waiting time is $3.00 per hour.

Usual airport limousine service will also be available.

Rental cars will be available from seven different companies. All seven companies have promised to cooperate with each other to provide the maximum in rental automobiles. Rates will range from $10 per day, plus 10 cents per mile for light cars to $15 per day and 15 cents per mile for the heavier cars.

Local transit lines will provide direct city bus service from downtown to the Exposition grounds at 30-minute intervals. The direct service will originate at 4th and Main Streets and run south to 15th Street, then east to the Exposition. Service will also be provided by all normal bus

schedules. The company says it will provide additional busses as warranted.

Hospitals

Any emergency which might arise in the way of illness can be taken care of immediately, both on the grounds and in the city. Major hospitals in the city contain over 2000 beds and all have excellent emergency and out-patient services.

On the IPE grounds is a small version of a hospital. On duty all during the show will be at least two registered nurses and doctors will be on call.

Entertainment

Visitors to the 1959 show will be impressed by the many civic activities that have been planned for this year's Exposition by the Tulsa Chamber of Commerce and a special citizens' committee, operating entirely independently of the IPE itself.

. . . Parades, Dances

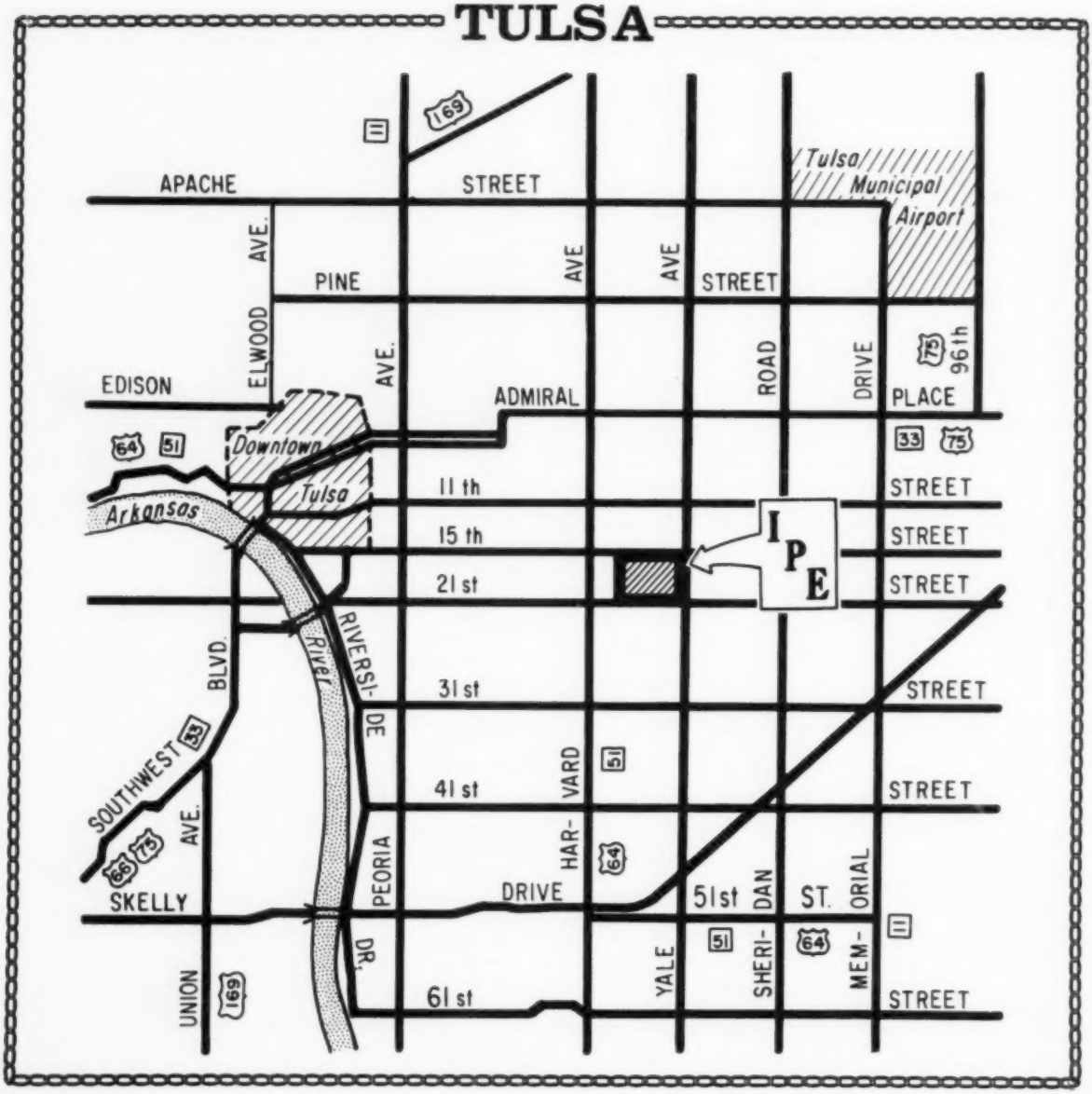
The downtown streets and buildings will be elaborately decorated around the Oil Centennial theme. A downtown parade will be held in which dozens of floats, representing oil states and nations and the 100th anniversary, will be entered in what promises to be a spectacular affair. Dances and special entertainment features will be offered throughout the ten-day event.

In addition to the regular entertainment feature of the Exposition itself and the many private parties and get-togethers in the city, Tulsa offers a variety of entertainment possibilities to the visitor.

. . . Special Civic Activity

The Tulsa Philharmonic Orchestra, one of the outstanding symphony orchestras in the country, will perform at various places during the show.

Tulsa Little Theatre is planning a special performance for visitors.



Engineers: Register here! Dwight Allison, Westinghouse Electric Corporation engineer, places one of several signs announcing the Technical Societies registration booth on the International Petroleum Exposition grounds. The booth is in the Petroleum Engineer Publishing Company's display and is open to all engineering and technical visitors.

. . . Restaurants

Several of the local restaurants are planning national talent for dinner guests. Among these is the show offered by Stauffer's restaurant — Pee Wee Hunt and his 12th Street Rag Band with an all-star floor show including Johnny Matson, Mona McCall, Tanya and Baigi and featuring Simone, The Silver Goddess.

Pierre's restaurant will feature Professor Backwards and Ford and Hines. Some of the clubs will also feature national entertainment for oil show visitors.

A partial list of Tulsa restaurants include:

Bishop's Restaurant, 512 South Main. Open 24 hours a day. Downtown meeting place.

Eddy's Restaurant, 2705 S. Harvard. Broiled steaks. Syrian dishes.

Jamil's, 2905 E. 51st. Hickory-grilled steaks, Syrian dinners.

Lola's Restaurant, 246 W. 11th. Pizza, seafood, spaghetti, steaks.

Louisianne, 118 E. 18th. Seafood, steaks, chicken, oysters, lobsters.

Pierre Restaurant, 3301 S. Harvard. Excellent steak. Dancing and entertainment nightly.

Villa Venice Restaurant, 6625 S. Lewis. Continental cuisine.

Western Village Dining Room, east of city. Well-regarded steaks.

Club Casbah, 3949 E. Admiral Place. Broiled steaks, lobster tails, fried chicken, Catonese dinners. Dancing and entertainment nightly.

. . . Golf

The oil man who has time for a round of golf will find some of the best golf courses in the country in Tulsa.

All the country clubs are making arrangements to offer club facilities to members of USGA accredited private clubs in the U. S., and are asking those desiring this service to have their own club write to one of the Tulsa clubs stating the member's name and his expected time in Tulsa so that bills may be returned to the visitor's own club for payment.

Private dinner clubs in the area are making similar arrangements.

Tulsa vicinity country clubs, and their locations and telephones are:

Meadowbrook Country Club, 81st and S. Memorial Drive, RI 3-1030.

Oaks Country Club, southwest of city, HI 6-6161.

Osage Hills Country Club, 1800 N. McKinley, Sand Springs, CI 5-9528.

Rolling Hills Country Club, east of city, VE 4-2249.

Southern Hills Country Club, 61st and South Lewis, RI 2-3351.

Tulsa Country Club, 800 N. Country Club Drive, LU 5-8153.

Woodland Country Club, 4000 N. Memorial Drive, TE 5-1529.

Tennis courts, bowling alleys, miniature golf courses, driving ranges and excellent fishing facilities are all readily available in the immediate Tulsa area.

Beauty greets the visitor to Tulsa during the 1959 oil show. Pat Riddle and Kay Mayer are just two of many from the Tulsa chapter of Desk and Derrick who will greet visitors at all major transportation terminals and the downtown hotels during the show. Just a word to one of the pretty girls at the IPE booth can arrange housing, transportation, literature and information about the Tulsa Oil Show.

. . . Women's Activity

Special events are being planned by the Tulsa Desk and Derrick Club, not only for women employed in the industry, but for wives of oil men as well. They are sponsoring the "Oil Woman of the Year" contest. The winner will be announced at a banquet and style show on the night of Saturday, May 16. That noon there will also be a style show and luncheon at a downtown hotel for visiting wives. In addition, the D and D will maintain information booths at airports, in hotel lobbies and on the IPE grounds. On one day of the exposition they will conduct tours of Gilcrease art museum, the Tulsa Rose Garden and other points of interest.

Old Timers committee chairman W. J. Sherry stands in front of the authentic replica of the Drake well on the grounds of the IPE. All awards to pioneers of the industry will be made in front of the structure.

Safety Engineers Contest

Not overlooking any phase of the vast industry, IPE officials have joined with the Tulsa Chapter of the American Society of Safety Engineers in sponsoring a contest for truck drivers in the industry. ASSE officials will conduct the contest and furnish the judges. Trucks have been classified in four different categories and each company has been asked to have a preliminary contest to pick the best driver in each of these divisions. Prizes include a "Series E" Savings Bond and a trophy for each winner. The contest is not limited to the oil business, according to L. F. Dougan, Sinclair Oil & Gas Co., chairman of the committee. "We have included all of the transportation companies who do so much work for those in the oil business."

Old Timers Feted

Eight "grand old men" of this ol' oil patch will be presented special gold medal awards at the show on Old Timers Day, May 17. Presentations to the eight chosen men, who have each served the industry more than 50 years, will be made by Paul Giddens, President of Hamline University and former curator of the Drake Museum at Titusville, Pennsylvania. The awards will be made near the replica of the original Drake well at the west end of the oil show grounds.

William J. Sherry, chairman of the IPE Old Timers Committee, has announced that awards will be made to the oil industry's "Pioneer of Pioneers," and to seven men who have distinguished themselves in their individual fields of service. These are: The Grand Old Man of Production, Grand Old Man of Drilling, Grand Old Man of Pipeline and Transportation, Grand Old Man of Natural Gasoline, Grand Old Man of Natural Gas, Grand Old Man of Refining, and Grand Old Man of Supplies and Equipment.

SCHEDULE OF EVENTS

. . . May 14-23, ten full days of fast-moving activities

THURSDAY, MAY 14
PETROLEUM WRITERS DAY
INTERSTATE OIL COMPACT COMMISSION DAY

Hosts for the day: Representatives from oil centers in the U.S.

Directors for the day: James E. Allison, D. D. Bovaird, Fred Mayer, W. H. Morris, Fred F. Murray, J. B. O'Connor, R. A. Baker, Bailie W. Vinson, Jay P. Walker, Joe B. Woods, James O. Breene, members of the Board of Directors of the International Petroleum Exposition.

9:45 a.m. Band concert in front of Texas Building, Drake Drive. Exposition gates open.

10:30 a.m. Formal opening ceremonies. Speaker's stand on top of Nomads Building, Drake Drive, Northwest corner of grounds.

11:00 a.m. Hall of Science opens. The entire world of oil science in miniature — the most complete and colorful summary of oil science ever assembled. Northwest corner of grounds.

Hall of Science Free Technical Film Theater opens. The story of oil on the screen with sound and color until 10:00 p.m.

All day: Registration of International Delegates, Nomads International Building, Drake Drive.

Registration of all Technical Societies, Petroleum Engineer Publishing Company, Display, Block A, Texas Drive and Mid-Continent Drive.

Governor J. Howard Edmondson and Mrs. Edmondson of Oklahoma receiving International Guests in Warren Penthouse by appointment all during the Exposition. Warren Building, 1350 South Boulder, Tulsa.

Registration of "Old Timers" of the oil world in "Old Timers" Headquarters House adjoining replica of Drake Well, southeast section of grounds.

Registration of press, radio, television, photographic and public relations representatives in IPE Press Room, ground floor of

Scientific and Technical Building, center of grounds.

"Drillin' Inn" cafeteria open. Serving beverages and food continuously until 9:30 p.m. Located on Skelly Drive at east end of grounds.

12:00 noon: Tulsa Chamber of Commerce Public Affairs Forum Luncheon honoring the opening of the Exposition. IPE visitors welcome. Chamber of Commerce Building, 616 South Boston, Tulsa.

FRIDAY, MAY 15

EXPLORATION DAY
ARMED SERVICES DAY
ENGINEERING STUDENTS DAY

Hosts for the day: Representatives from oil centers in the U.S.

Directors for the day: Frank J. Hinderliter, G. H. Westby, R. B. Warren, Wm. G. Dudley, H. F. Worley, Jr., E. H. McCollough, David A. Bartlett, W. A. Fleming, George Parker, R. O. Dietler, members of the Board of Directors of the International Petroleum Exposition.

10:30 a.m. Exposition gates open

All day: Registration of International Delegates
Registration of all Technical Societies
Registration of "Old Timers"
Registration of Press, Radio, TV Representatives
Hall of Science opens
Hall of Science Free Film Theater opens
Drillin' Inn cafeteria open

10:00 p.m. Exposition gates close

SATURDAY, MAY 16

AMERICAN PETROLEUM INSTITUTE DAY
DRILLING DAY
NORTH DAKOTA DAY
DESK AND DERRICK DAY

Hosts for the day: Representatives from oil centers in the U.S.

Directors for the day: John W. Brice, E. F. Bullard, Clyde H. Alexander, Frank M. Porter, Rainey Elliott, John S. Freeman, James W. Foley, A. W. McKinney, P. C. Lauinger, S. A. Guiberson, Jr., members of the Board of Directors of the International Petroleum Exposition.

10:30 a.m. Gigantic Downtown Parade
Exposition gates open

All day: Registration of International Delegates
Registration of all Technical Societies
Registration of "Old Timers"
Registration of Press, Radio, TV Representatives
Hall of Science opens
Hall of Science Free Film Theater opens
Drillin' Inn cafeteria open

1:30 p.m. Desk and Derrick luncheon and style show

7:00 p.m. Dinner for visiting Desk and Derrick Club members with presentation of "Oil Woman of the Year" award

10:00 p.m. Exposition gates close

SUNDAY, MAY 17

"OLD TIMERS" DAY
FAR EAST DAY
WICHITA DAY

Hosts for the day: Representatives from oil centers in the U.S.

Directors for the day: W. L. Connelly, Alf Heggem, E. B. McFarlin, Sam Gladney, Michel T. Halbouty, W. S. Hallanan, A. F. Bourne, Barney Majewski, W. H. Helmerich, E. J. Murray, H. R. Powers, members of the Board of Directors of the International Petroleum Exposition.

10:30 a.m. Exposition gates open

All day: Registration of International Delegates
Registration of all Technical Societies
Registration of "Old Timers"
Registration of Press, Radio, TV Representatives
Hall of Science opens
Hall of Science Free Film Theater opens
Drillin' Inn cafeteria open

5:30 p.m. Memorial service for "Old Timers" of the oil industry, at "Old Timers" Headquarters on the Exposition grounds. Speaker is Dr. Paul H. Giddens, President of Hamline University, St. Paul, Minnesota.

6:00 p.m. Presentation of "Pioneer of Pioneers" and "Grand Old Man" awards by Exposition "Old Timer's" Committee.

10:00 p.m. Exposition gates close

MONDAY, MAY 18

PRODUCTION DAY
CANADA DAY

Hosts for the day: Representatives from oil centers in the U.S.

Directors for the day: I. C. Huff, Anthony F. Keating, Grover Kilgore, T. N. Law, A. O. Olson, N. G. Henthorne, J. U. Teague, P. C. Spencer, Waite Phillips, Wirt Franklin, G. C. Parker, members of the Board of Directors of the International Petroleum Exposition.

8:30 a.m. Exhibitors' breakfast at Drillin' Inn Cafeteria. All exhibitors urged to have a representative present. Wm. B. Way, general manager of the International Petroleum Exposition, will be host, and the meal is "on the house."

10:30 a.m. Exposition gates open

All day: Registration of International Delegates
Registration of all Technical Societies
Registration of "Old Timers"
Registration of Press, Radio, TV Representatives
Hall of Science opens
Hall of Science Free Film Theater opens
Drillin' Inn Cafeteria open

10:00 p.m. Exposition gates close

TUESDAY, MAY 19

PIPELINE DAY
ENGINEERS DAY
SOUTH AMERICA DAY

Hosts for the Day: Representatives from oil centers of the U.S.

Directors for the day: J. L. Latimer, W. C. Whaley, A. I. Levorsen, Ed H. Salrin, Richard Lloyd Jones, Jr., P. D. Hayes, Charlton H. Lyons, T. W. Mayborn, Clarence H. Wright, Dean McGee, R. E. Reimer, members of the Board of Directors of the International Petroleum Exposition.

10:30 a.m. Exposition gates open

All day: Registration of International Delegates
Registration of all Technical Societies
Registration of "Old Timers"
Registration of Press, Radio, TV Representatives
Hall of Science open
Hall of Science Free Film Theater open
Drillin' Inn Cafeteria open

12:00 noon: Tulsa Junior Chamber of Commerce luncheon; honoring IPE visitors. Tulsa Chamber of Commerce Dining Room, 616 South Boston

6:30 p.m. IPE Engineer's Day Banquet sponsored by American Society of Mechanical Engineers, Topaz Room, Hotel Tulsa

10:00 p.m. Exposition gates close

WEDNESDAY, MAY 20

NEW MEXICO DAY
INTERNATIONAL DELEGATES DAY
NATURAL GAS DAY
AFRICA DAY
NOMADS DAY

Hosts for the day: Representatives from oil centers of the U.S.

Directors for the day: W. K. Warren, W. L. James, C. A. Prichard, J. A. LaFortune, Robert F. Pielsticker, Gordon Simpson, N. C. Simpson, John Staudt, L. A. Sunkel, members of the Board of Directors of the International Petroleum Exposition.

10:30 a.m. Exposition gates open

All day: Registration of International Delegates
Registration of Technical Societies
Registration of "Old Timers"
Registration of Press, Radio, TV Representatives
Hall of Science open
Hall of Science Free Film Theater open
Drillin' Inn Cafeteria open

5:30 p.m. Nomads Cocktail Party honoring all International Delegates, Southern Hills Country Club

10:00 p.m. Exposition gates close

THURSDAY, MAY 21

REFINING DAY
SOUTHERN OKLAHOMA DAY
EUROPE DAY
MID-CONTINENT OIL & GAS ASSOCIATION DAY
PURCHASING AGENTS DAY

Hosts for the day: Representatives from oil centers of the U.S.

Directors for the day: J. L. Shakely, Clarel B. Mapes, R. Otis McClintock, Wm. H. Garbade, James H. Gardner, J. Burr Gibbons, D. E. Buchanan, John E. Mabee, Harry A. Waddell, Robert W. Wire, members of the Board of Directors of the International Petroleum Exposition.

10:30 a.m. Exposition gates open

All day: Registration of International Delegates
Registration of all Technical Societies
Registration of "Old Timers"
Registration of Press, Radio, TV Representatives
Hall of Science open
Hall of Science Free Film Theater open
Drillin' Inn Cafeteria open

6:30 p.m. Purchasing Agent's Reception and Buffet

10:00 p.m. Exposition gates close

FRIDAY, MAY 22

NATURAL GASOLINE DAY
MIDDLE EAST DAY

Hosts for the day: Representatives from oil centers of the U.S.

Directors for the day: R. W. McDowell, Rush Greenslade, W. A. Schlueter, J. H. Satterwhite, Roland V. Rodman, Warner Lewis, Frank R. Billingslea, F. O. Prior, C. R. Zimmerman, members of the Board of Directors of the International Petroleum Exposition.

10:30 a.m. Exposition gates open

All day: Registration of International Delegates
Registration of all Technical Societies
Registration of "Old Timers"
Registration of Press, Radio, TV Representatives
Hall of Science open
Hall of Science Free Film Theater open
Drillin' Inn Cafeteria open

10:00 p.m. Exposition gates close

SATURDAY, MAY 23

PETROCHEMICAL DAY
SAFETY DAY
NORTH AMERICA DAY
TEXAS DAY

Hosts for the day: Representatives from oil centers of the U.S.

Directors for the day: J. H. Brooks, K. S. Adams, Dr. C. I. Pontius, A. E. Bradshaw, J. P. Flanagan, L. F. McCollum, R. E. Day, Ralph B. Pringle, Robert C. Sharp, members of the Board of Directors of the International Petroleum Exposition.

10:30 a.m. Exposition gates open

All day: Registration of "Old Timers"
Registration of all Technical Societies
Registration of Press, Radio, TV Representatives
Hall of Science open
Hall of Science Free Film Theater open
Drillin' Inn Cafeteria open

10:00 p.m. International Petroleum Exposition Ends.

INTERNATIONAL VISITORS

. . . Meet your Nomads Hosts

OVERSEAS VISITORS to the 14th International Petroleum Exposition will receive just about every consideration and aid it is possible to give them, according to Don L. Collins, IPE Nomads chairman. Members from all five of the National Order of Manufacturers and Delegates Society chapters in the United States have pooled their resources and ideas to make the upcoming show the largest in history, at least from the international aspect.

Although the show is a month and a half away, reservations have been pouring in and already the number of international visitors planning to attend far exceeds the number actually present at the last Exposition in 1953. Requests for housing have been received from 42 different countries, and the total number of foreign delegates who will attend is now over 1500. Total registration in 1953 was 785.

Nomads headquarters on the oil show grounds have been redecorated and newly furnished and plans are complete for the various services offered to the overseas visitor.

Interpreter Service

Of primary interest to the non-English speaking visitor are the arrangements for interpreter services. The International Club of Tulsa, an organization of multi-linguists, has offered its complete cooperation and as a result, interpreters will be on hand in the Nomads headquarters and at the major downtown hotels throughout the 10 days of the show.

Foreign Exchange

For the visitor who wishes to make additional travel arrangements or change some of his own country's currency into U.S. dollars, the Nomads have secured the services of the Universe Travel Agency of Long Beach, California, and the agency has set up an office both in the international headquarters and in downtown Tulsa. Ron Fenwick, president of the agency, says he will be able to handle almost any emergency that could arise with travel or currency matters.

The Governor of Oklahoma, J. Howard Edmondson, and Mrs. Edmondson will receive dignitaries by appointment in the Warren penthouse any time during the show. Governor Edmondson said he would consider it an honor to meet and talk with any of the distinguished visitors to the state and hopes they will take time to see him.

'Field' Service

The visitor who wishes to see some of the oil equipment actually working in the field may do so by contacting any of the Nomads members. Men and vehicles will be available to make any tour in the area that the visitor wishes.

Four limousines with drivers who know the area are on duty at the show grounds all during the Exposition for international visitors' use. Collins said that the Nomads will provide more cars if necessary. Also, plans are to have limousines on duty at the airport for overseas delegates' use.

Three people responsible for Nomads activities on the grounds are Don L. Collins, IPE Nomads chairman, vice president of Republic Supply Company; Arch Campbell, Nomads headquarters manager; and Oscar B. Irizarry, Tulsa Nomads chapter president, editor of Petroleo Interamericano.

Party

A traditional highlight for international delegates is the Nomads cocktail party. This year the party will be held at Southern Hills Country Club on May 20, from 5:30 p.m. until 8:30 p.m. The event will be on the lawn of the club and in case of inclement weather, a "rain check" has been provided for the next day, May 21. Officials say they expect between 3500 and 4000 to attend the gala affair.

Over 5000 personal invitations have been mailed to Nomads customers and acquaintances in other countries and personal invitations issued to countless other dignitaries by the IPE's traveling ambassadors corps.

Collins emphasized the fact that Nomads members are on duty all during the show with one purpose in mind: To help any international visitor with any problem or question that should arise in Tulsa or in the United States.

HALL OF SCIENCE

. . . Showcase of scientific and engineering advancement

George Roberts, Jr.
IPE Hall of Science Chairman, and Manager of Research, Pan American Petroleum Corporation Tulsa, Oklahoma

THE HALL OF SCIENCE will be an outstanding feature of the International Petroleum Exposition to be held in Tulsa, May 14-23, 1959.

The main theme is to show — by working models, exhibits, and other means — the outstanding scientific and technical developments of the past few years. In addition to this, because this is the 100th anniversary year of the drilling of the Drake well, there will be some emphasis on historical developments.

The scientific and engineering accomplishments of the oil industry are second to none and all people connected with the industry should be justly proud.

The Hall of Science offers some unique opportunities. Oil industry people themselves will be able to see in one place the outstanding scientific developments in the industry. The general public will see displayed clearly and attractively many things which will give them a better idea of how the oil industry operates. In addition to the displays, there will be competent people to explain the scientific exhibits and answer questions.

The Hall of Science will be divided into seven divisions: Geology, geophysics, production, transportation, refining, petrochemicals and technical films.

Geology

The geological exhibit will highlight the historical development of ideas and methods used in exploring for oil, and then dwell in more detail on certain new techniques now in use or being developed by the industry to aid the increasingly difficult search for new reserves.

First will be a series of historical panels on the various ideas that have been used in oil finding. This will lead from the early use of seeps and tar pits, through creekology, to modern geologic and seismic techniques. It will end with maps of the U.S. at various periods since 1859, showing the geographic extension of oil producing provinces, including those that have yet to be explored. It will also emphasize the current major problem in exploration, that of finding stratigraphic traps.

The rest of the exhibit will be devoted largely to newer techniques, developed during the last five or six years. There will be an exhibit on microfossils, specifically on spores and pollen. It will include a panel explaining the floral and faunal evolution which is the basis of all paleontology. It will then show a diorama explaining where various kinds of microfossils come from and how they are incorporated into bottom sediments in the ocean. It will also describe methods of isolating these microfossils from the rock and give several photographs of model representations of spores and pollen.

The next exhibit will show five panels describing absolute age dating. This will include the carbon-14 and potassium-argon techniques as well as a general description of the methods of geochronology that are applicable in exploration geology.

Tying these two exhibits on microfossils and absolute age dating together will be a large animated panel explaining the need for correlation. It will consist of a diagrammatic picture of a typical oil basin and show the sequence of drilling that might be conducted. It will move from

Executive committee for the IPE Hall of Science, looking over the building layout, are R. L. Langenheim, H. A. Brown, J. P. Hammond, George Roberts Jr., Wm. B. Way (IPE general manager), T. R. Aude, K. T. Kimball, John Staudt, R. M. Leader, Stanley Wilcox, and H. J. Schaetti.

Transportation division of the Hall of Science features this working model of an automatic pipeline system, complete with working pumps, tanks, manifolding and simulated microwave system for remote control of all operations from the central dispatching point.

drilling on surface anticlines to the search for salt dome, reef and unconformity oil. It will be explained by a voice recording synchronized with the movement on the panel, and will form the core of the geological exhibit, serving to tie the various parts into an integrated unit.

A further exhibit will be concerned with work on recent sediments and will include much oceanographic and deep sea research.

The use of maps of various kinds in exploration today will form another part of the geological exhibit. New mapping techniques will be demonstrated in a form that should be understandable to the layman and also convey something of interest to the specialist.

Finally, there will be a panel illustrating the risk aspect of exploration in some suitable form.

Photographs of geologists at work and certain cartoon-type comments on striking facts of exploration interest will be dispersed throughout the exhibit.

Geophysics

New instrumentation, new findings and new concepts in exploration geophysics will be the theme of the geophysical exhibit in the Hall of Science. The visitor will be able to get a wide background of acquaintance with the employment and results of the use of geophysical methods. The recent International Geophysical Year will have some representation and explanation. As a background some 40 posters will illustrate geophysical measurements and results.

The actual exhibits will include such items as an earthquake recording drum, activated by a new earthquake seismograph instrument installed on the University of Tulsa campus, sound records of a recorded earthquake and of the Mount Rainier atom bomb explosion, a model seismograph recording pulses on an oscilloscope, and a spring seismograph model. Seismic equipment will also be represented by the first reflection equipment used by the Marland Oil Company contrasted with the latest transistorized equipment. A "smoke-eater" device will burn recordings on special paper.

A special display will show a flying magnetometer in action. Another moving display will illustrate gravity meter measurements.

Data processing devices for seismic recordings will be shown, along with instruments used in the interpretation of gravity data.

If possible, a satellite, which is the ultimate in geophysical instruments, will be on display.

Production

The Production Division is planned to emphasize exhibits showing developments in the last five years with basic information on production procedures, to attempt to weave a complete story starting with the drilling of a well and ending with reservoir engineering. It will be broken into four segments: Drilling, Testing and Completions, Production Processes, and Reservoir Engineering.

The Drilling segment, in recognition of the 100th anniversary of the drilling of the Drake well, will show models of drilling rigs including a springpole rig, a very early cable tool, a modern cable tool, and the latest rotary drilling. In addition, the original tools which were used in the drilling of the Drake well will be on display through the courtesy of the Drake Museum at Titusville, Pennsylvania. The latest drilling equipment will be displayed, including the percussion drill and the turbodrill, together with a model of an offshore drilling rig and platform.

The Testing and Completions section will display models of new tools developed for both coring and drillstem testing without coming out of the hole, wire line formation testing equipment, and an animated model showing the principles of formation fracturing, together with models showing some of the latest developments in fracturing techniques. A display is being prepared showing various types of well completions, including quadruple completions through the same bore hole. Another display will illustrate permanent type well completion techniques.

There will be displays of various production processes, including the latest developments in the pumping of wells and the handling of crude oil on the lease. A model will show lease automatic custody transfer equipment handling crude oil production. Equipment will be displayed that automatically takes and records well production tests. This will be coordinated with an electronic computer demonstrating how well production tests in the field can be transmitted directly to office records and plotted curves. A newly developed method of detecting outside corrosion on casing and of economically patching casing leaks will be displayed.

The Reservoir section will contain displays showing porosity and permeability of reservoir rocks with fluids bubbling through cores of different permeabilities; a colorful animated model will demonstrate in-situ combustion in a reservoir and its progress through the reservoir rock; the flow of fluids through reservoir rocks depicted by models of various kinds of reservoirs together with film strips showing these models being waterflooded.

Transportation

The Transportation Exhibit will show recent developments in all phases of petroleum transportation.

One of the larger exhibits will be a working model of an automatic pipeline system, remotely controlled from a central dispatching board. The model pipeline itself will

Refinery, from a bird's eye view, will be illustrated with an 8 by 16-ft scale model of a 230,000 bbl per day plant. Several of the best exhibits from the Science for Youth Fair will be shown in the Refining Division of the Hall of Science.

consist of two Lucite model tanks at the origin, and a model electrically driven centrifugal pump station adjacent to these tanks. In the middle will be a second, or relay, station. At the delivery end will be two more model tanks with necessary manifold. Also included in the exhibit will be a simulated microwave system for the remote control of all operations from the central dispatching point.

As part of this exhibit, there will be a model of a variable speed fluid drive to accommodate pump speed to the operating conditions of the pipeline. Also included will be a data logger (or teleprinter) which from time to time will print out all conditions of pressure and flow. There will also be a television screen on which will be shown meter readings of positive displacement meters at the delivery manifold.

Another exhibit will include a model of an electric centrifugal compressor station and a modern turbine driven centrifugal compressor station for a gas pipeline.

The latest developments in tank trucks and tank cars for petroleum and petroleum products will be shown by appropriate models and photomurals.

To show water transportation, there will be a scale model of an ocean-going tanker, designed to carry liquefied petroleum gases, as well as a scale model of a modern river towboat and barges for the transportation of petroleum and petroleum products on the inland waterways.

Of considerable interest will be a model of a caisson for the repair of underwater lines. This will be an actual working model of a device which may be lowered from the surface of the water to surround the pipeline, 10, 15, or more feet below the surface of the water. It is operated hydraulically to close around and seal against the pipeline and may then be pumped dry. Men can then enter the caisson to make welding repairs or connections to the pipeline.

Refining

The Refining Exhibit will be designed to show the public a bird's eye view of a refinery plant as well as typical scenes of the refining industry and related activities. There will be an 8 by 16 ft scale model of a 230,000 bbl per day refinery. Around the room, on the walls, will be hung some 10 to 20 paintings in oil, water color, and lithography. These paintings are from an oil industry collection in an outstanding art museum.

What goes on in the refinery will be shown by means of a diagrammatic board. There will be displays of end products with which the public is familiar. A basic theme of constant product improvement will be emphasized.

There will be exhibits of specific process units, graphic control boards, industrial training aids, and a novel quizzing machine which will interrogate the public on information displayed around the room. Two electronic graphic control boards will be displayed with analog simulated operation. Corresponding scale models of two process units will also be displayed. Other scale models will be displayed along with information display cards illustrating capacity, investment cost, operating manpower utilities, the quality of the products, etc. The basic theme will be the refining industry's responsibility to engineer and build more competitive process plants which provide better jobs and better products at a lower cost.

Also, to be shown in this room will be several of the best exhibits from the Science for Youth Fair.

Petrochemicals

The central theme of the petrochemical exhibit is the rapid growth of the petrochemical industry and the many benefits derived from the products and services of that industry.

About 25 key petroleum and chemical companies with major petrochemical interest are cooperating in the design and construction of this wholly integrated exhibit.

In a colorful treatment, this exhibit will be subdivided into four major centers of interest. The first will present the broad scope of the petrochemical industry, showing how the basic raw materials of crude oils and natural gas are processed along with raw materials from other industries into the valuable petrochemicals which are the key to the manufacture and fabrication of the consumer products.

In another section, the viewers will be introduced to their neighbors in all walks of life who contribute their services and make these petrochemical products possible. In still another, the petrochemical benefits now being achieved in a wide variety of vocations will be depicted and simply explained.

The concluding section of the exhibit will be devoted to enumeration of the current and future benefits to the consuming public which petrochemicals bring about in the advancement of improved standards of living. For example, the public attention will be directed to the important role of petrochemicals in better health, greater safety, less expensive and longer lasting consumer goods and increased enjoyment of leisure time.

Technical Films

Again the IPE will feature in the Hall of Science a movie theater which will continuously show outstanding movies portraying various phases of the oil business. Included with them will be some films of entertainment interest.

This theater, attached to the Hall of Science, will accommodate 120 people and is air conditioned where continuous showings will take place from 10 a.m. to 10 p.m. for the 10 days the exposition is in operation. The show will include the outstanding documentary and industrial presentations of the oil business.

All in all, an outstanding scientific and technical picture of the oil industry will be presented. Many outstanding oil men in all phases of the industry are among the 75 committee members and consultants who are participating in this endeavor. Among the committee chairmen are: Henry J. Schaetti, Jersey Production Research; Paul L. Lyons, Sinclair Oil and Gas; Theodor R. Aude, Service Pipe Line; Harry A. Brown, D-X Sunray Oil; R. M. Leader, Phillips Petroleum; John P. Hammon, Amerada Petroleum, and Stanley W. Wilcox, Seismograph Service.

Kent T. Kimball is executive secretary, and consultants include B. B. Weatherby, Amerada Petroleum; Gerald H. Westby, Seismograph Service; Dean R. L. Langenheim, University of Tulsa, and John G. Staudt, Dowell. ★ ★ ★

Who's Showing What . . . and Where

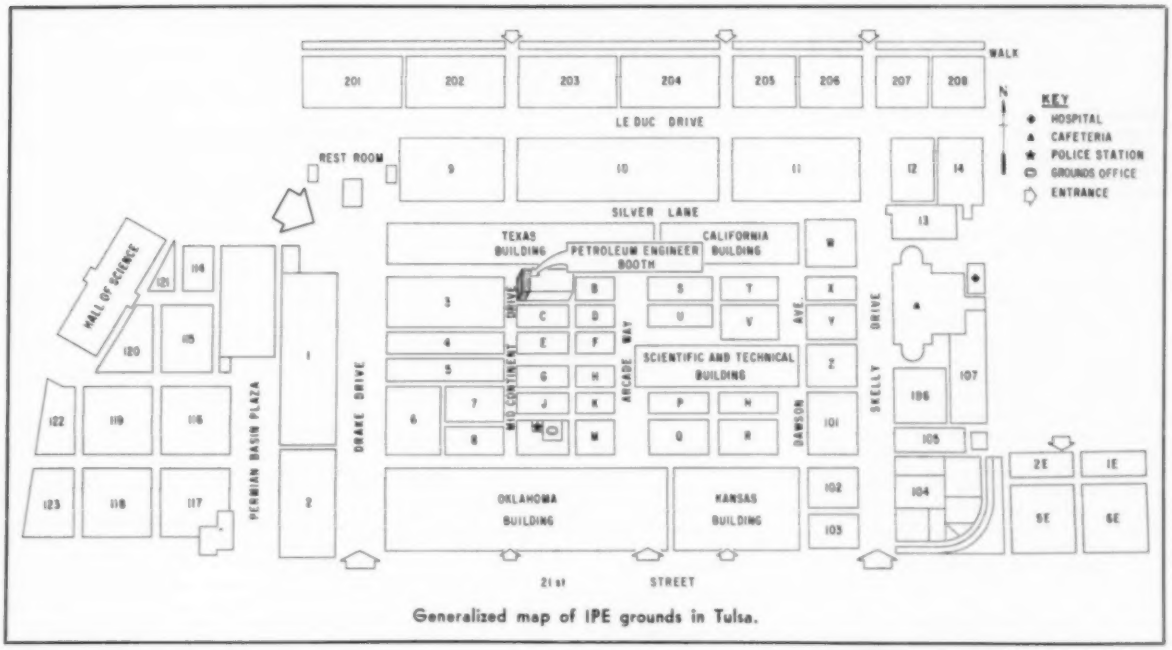
A comprehensive directory of every exhibitor, location of exhibit, equipment shown and company representatives attending IPE

If you've never attended an international oil show before, your first impression may be one of mass confusion, like that of a bird dog in the midst of a flushed covey of quail. But, you can be assured that there is considerable organization in the maze of petroleum equipment, services and products you'll find in Tulsa May 14 - 23, 1959. One thing is certain, however, you can easily spend the full two weeks of the show looking at and learning about the thousands of items on display. But, you only plan to be at the show for a limited time, and it would be a tremendous problem for you to figure out just what you should see to satisfy your prime interest.

The editors of The Petroleum Engineer and all its four specialized editions have done much of the organizing for you so that you can quietly and efficiently plan what to see, who to see and where to see it . . . even before you arrive in Tulsa. The following pages contain the keys to planning your Oil Show visit. It is a complete and official list of every company to exhibit at IPE. Arranged in alphabetical order are the names of companies you will find represented at the Oil Show. Next is the location of their exhibit or booth . . . which can be found on the IPE Show Grounds Map.

Types of equipment. Hundreds of thousands of items of equipment, services and products have been carefully screened and cataloged according to type or category. This is given after the exhibit location.

Who's who? Many visitors will be looking for a friend with whom they have done business in the past. Will they be at the show? You'll find this information in the last part of the listing under the company name. Or, you may want to ask for a specific company representative. This list is intended to help you.



Generalized map of IPE grounds in Tulsa.

Alphabetical Listing of Oil Show Exhibitors

A

Aaron Machinery Company, Inc.
North Area, Booth 56W

Abegg & Reinhold Co.
Silver Lane, Booths 2, 3, 4

Kelly bushings, master bushings, rotary slips, casing and tubing, drill collar slips and clamps, safety collar clamps, and integral tubing joints.
W. H. Spiri, H. I. Lorenz, W. B. Reinhold, J. A. Drexel, W. Geeslin, E. Gray, M. Heitman.

Acme Fishing Tool Co.
California Bldg., Booths 47, 48

Percussion drilling, fishing tools.
Karl L. Elliott, Walter P. McKain, D. W. Wilcox, M. E. Zumbro, M. E. Hoffman.

Acme-Newport Steel Company
North Area, Booth 77N

Adams Pipe Repair Products
Oklahoma Bldg., Booth 56

Aerequip Corporation
Oklahoma Bldg., Booths 138-191

Aerotron Radio Company
North Area, Booth 29N

Air Reduction Sales Co., Div. of Air Reduction Co., Inc.
Oklahoma Bldg., Booths 30, 31

Welding torches, tips and regulators, welding rods, safety hats and caps.

I. B. Yates, E. H. Roper, H. O. Jones, J. W. Cunningham, J. R. McClendon, H. D. Mann, O. F. Wilkinson, A. E. Gander, J. C. Frick, C. T. Burggraf, W. C. Bettes, R. C. Casper, J. E. Blesi, W. Champion, W. W. Littlefield, S. Treadwell, A. E. Kennedy, J. I. Sampson, G. F. Victor, L. D. Sugg, L. A. Ragone, H. F. Colt, J. W. Bramble, J. Lund, H. J. Korner, L. T. D. Berg, E. DiLiberti, H. Hooper, R. S. Schmidt, E. S. Twining.

The Airetool Mfg. Co.
Oklahoma Bldg., Booth 151

Tube cleaners, tube expanders, tube expansion controls, tube cutters, portable pneumatic drills, grinders, screwdrivers and nutsetters.

Thor Thornson, James Brown, James Kueker, E. Segraves, G. Sanders.

Air-X-Changers, Inc.
North Area, Booth 22N

Fan cooled heat exchangers for skidded compressors.

Murray Carr, Lee Allen, L. M. McCright, Ralph Eads, Chuck Lundelius, Jack Holland, Roy Bass, Kenneth Bass, John Hesse, Gene Parker, Walter Perkins, Harold Musgrove.

Ajax Iron Works
National Supply Company and Bethlehem Supply lots.

Two-stage compressor units and engines.

J. H. Castor, J. C. Rudolph, C. I. Rainesalo, C. T. Piorotti, J. H. Castor, Jr., L. H. Lanphere, H. O. Platt, L. H. Carson, G. P. Elwood, R. H. Straitiff, J. L. Turner, K. W. Yount.

Albina Engine & Machine Works, Inc.
Booths 5-N and 6-N

Powered scafolding equipment.

P. L. Symons, E. A. Cooley, Harry Drumm, Ed Hayes, Harel Bennett.

The Aldrich Pump Company
California Bldg., Booths 30, 31

Allan Edwards, Inc.
California Bldg., Booths 1 - 6

Mixing Equipment Co.: fluid agitators; Magnetrol, Inc.: liquid level alarms; Thermo-Panel Div., Dean Products, Inc.: coil panels of plate construction; Dustex Corp.: miniature cyclone dust collectors; Autoclave Engineers, Inc.: high pressure research equipment; Oceco Div., The Johnston and Jennings Co.: conservation vent valves; Lapp Insulator Co. Inc.: proportioning pumps; The Electric Hotpack Co. Inc.: industrial ovens, furnaces and baths; Vibra Screw Feeders, Inc.: solids apprational feeder; Allan Edwards, Inc.: concrete river weights and aerial pipeline markers.

J. V. Donohoe, Richard Boutros, Milton Dykman, Jim Mason and Lou Mahony (Mixing Equipment Co. Inc.); Rubin Raskin (Thermo-Panel Div., Dean Products, Inc.); Larry Crick and Hamilton Hazel (Dustex Corp.); Joe Allison, R. L. "Bob" Porter, and Fred Gasche (Autoclave Engineers, Inc.); George Fox (Oceco Div., The Johnston and Jennings Co.); Donald Williams (Lapp Insulator Co.); Allan Edwards Sr., Allan Edwards Jr., Jack Osborn, Bruce Pettigrove, Lloyd K. Crocker and Jim Rodgers (Allan Edwards, Inc.).

Allen Gauge & Tool Co.
Kansas Bldg., Booth 64

Pipe and pipe thread-tools and inspection gages.

R. C. Allen, Charles H. Allen Jr.

Allied Bearings Supply Co., Inc.
S&T Bldg., Booths 1, 2

Ball and roller bearings, special tools for removing and installing bearings, high and low speed couplings, speed reducers, oil seals and retaining rings.

P. G. Hull, W. H. Allen, H. V. Davis, C. W. Riddle, W. R. Allton, Frank Schad, C. W. Sparks.

Allied Chemical Corporation
Kansas Bldg., Booth 52

Allied Paint Mfg. Company
Oklahoma Bldg., Booth 259

Louis Allis Company
Kansas Bldg., Booths 48, 49

Allis-Chalmers Mfg. Company
Block M, Oklahoma Dr. & Arcade Way

Diesel and gas engines, generator sets, crawler tractor, motor grader, electric motors, pumps, electric control, fork lift truck, 240 hp, 340 hp diesel engines, 175 kw diesel engine generator set and 40 and 60 hp gas power units.

J. C. Baseheart, Fred Borwell, Burt Clark, Lou Beal, Harvey McNaughton, Howard Bindrim, Howard Cohenour, W. A. Hart, L. C. Daniels, A. E. Vining, John Peschka, Eddie Gibbens, E. J. Mercer, A. E. Dorn, V. M. Holloway, J. M. Haile, G. E. Hall, A. E. Thode, N. A. Pohl, C. J. Stutzman, F. Carpenter, E. Boyken, D. Cavanaugh, R. W. McKee, O. Brynelsen, Frank Nolan, John DiTrapani, R. I. Moore, Ed Blakestad, George Brooks, Jim Fenske, P. Kimball, H. Kingsbury, D. Lory.

Alten Foundry & Machine Works, Inc.
Outside Display, Block L

Pumping units, a gear reducer, well head equipment, tubing heads, stuffing boxes, polished rod clamps, etc.

Warren M. Benson, Paul H. Scherf, Merle R. Ruff, R. R. Matthews, Fred R. Bayne, C. W. Moyer, W. A. Morris, W. B. Hudson, W. A. Belcher, B. L. Ledeker, D. M. Hodges, D. D. Frankland, Robert McCauley, E. F. Brooks, Mitzi.

Aluminum Company of America
S&T Bldg., Booths 52 - 55

Scale model of an aluminum drilling and producing platform. Aluminum drilling rig supply pipe and fittings, product piping with integral steam tracing, heat exchanger tubes, pipe with variable wall thickenss having standard wall thickness at the ends and thinner wall thickness along the length, hand railings and fittings, chain link fence, die cast stair tread, roofing and siding, building panels, conduit, casting, forgings, and alumina chemical products.

E. T. Wanderer, E. D. Verink, H. P. Bonebrake, W. S. McChesney, C. M. Conklin.

American Air Filter Co., Inc.
Texas Bldg., Booths 16, 17

Air intake filters and horizontal gas cleaner.

G. C. Rodgers, D. M. McMakin, K. U. Meguire, J. K. Sparrow, Leonard O'Dell, Robert D. Moore, Dallas S. Deem, Roger Knopp, J. H. Wills, C. B. Arterburn, J. A. Ray.

American Bosch Division, American Bosch Arma Corp.
Oklahoma Bldg., Booths 34, 35

Hydraulic cranking systems, ignition equipment, dual fuel injection equipment and automotive electrical equipment.

Harold R. Sennstrom, Bertram Cole, Richard C. Keane, Robert M. Whelan, Ray Vaughn, Robert FitzGibbons, Octavus Eaves, John R. O'Donnel.

The American Brass Company
Texas Bldg., Booths 55, 56

American Chain & Cable Co., Inc.
Oklahoma Bldg., Booths 157, 158, 173 - 176

Chain, cable, hoists, gages, valves.

The American Coleman Company
North of Block 12

American Gas Journal
Corner Mid-Continent at Texas Dr.

Joe B. Woods, Abbott Sparks, E. V. Perkins, J. E. Kastrop, John McDonald, Clyde Dillehay, Robert T. Mahoney, Richard P. McKey, Art Gilliam, Jess Adkins, Ed Sealey, Paul Mansfield, Dean Hale, Royal Courtney, Charles McKean, Sherwood Entwistle.

American International Underwriters Corp.
Oklahoma Bldg., Booth 239

American Iron & Machine Works Co., Inc.
Oklahoma Bldg., Booths 159, 160, 161

Open hole tool joints for light weight drill pipe, flashwelded tool joints, straight grip tool joints, integral drill collars, rolflex drill collars, hex and square kellys, slush pump valves and seats, slush pump pistons, friction makeup and breakout catheads, overshots, control head packers, packer hold downs, tubing anchors.

M. G. McCool, E. E. Rubac, W. R. Wheeler, Jr., Wm. H. Barry, David Beachum, Ross Bonano, LeRoy Burner, Jerry Burney, James W. Caffey, Ben Cherski, Bryan Curtis, Ross Day, C. P. Delahoussaye, Raif Erisken, B. R. Foster, Ray Henry, Kenneth Kirkpatrick, Charles Landers, Herman Lawson, Walt McCharen, Robert T. McKenzie, Charles E. McMullen, Jr., Roy Meredith, William Miller, T. E. Orrell, Nelson Peeler, Jim Rea, W. W. Schwartz, Glen Severs, B. E. Sharp, E. M. Slatte, Bob Smith, Sidney Spilbury, Robert Stiewel, J. M. Taylor, Joe Thompson, Guy W. Tucker, F. E. Wagner, H. Wotkyns, T. J. Zimmerman.

American Kloeckner-Moeller Corp.
North Area, Booth 35 N-36 N

Electric oil field pumping controls, motor controls, motor control load centers.

B. D. Chumley, Rudolf Gobbe, Paul Huska, Geo. A. Pugh, Wanda Grace, Gert Moeller, B. W. Vandiver, B. G. Marsh, Don Chumley.

American Meter Company
S&T Bldg., Booths 45 - 46 - 57 - 58

American Pullmax Co., Inc., Piston Products, Inc.
Park Lane, Booths 5 and 6 (Joint booth)

Sheet metal shearing and forming machines. Diesel engine piston rings and liners.

American Pullmax Co., Inc.: E. G. Kihlstrom, L. W. Behrendt, N. F. Black, R. R. Nehf, C. M. Sharp, D. H. Talmage.

Piston Products, Inc.: Hans Bohuslav.

American Recording Chart Company
Oklahoma Bldg., Booths 179 - 180

American Roller Bearing Co.
Silver Lane, Booth 21

Roller bearings.

W. G. Succop, C. L. Knaak, W. J. Schwartz.

American Valve Reconditioning Co., Inc.
Kansas Bldg., Booth 53

Work samples of actual reconditioning of many different styles and types of valves.

Charles A. Raimondi, James F. Flajnik, E. J. Campbell.

Ampco Metal, Inc.
California Bldg., Booths 32, 33, 34

Materials of construction, aluminum bronze pipe and fittings. Pump fluid ends, centrifugal pumps, spark-resistant, corrosion-resistant safety tools, aluminum bronze welding electrodes, wire, and an aluminum bronze fabrication alloy in sheets and plates.

I. S. Levinson, G. E. Brown, J. P. Marischen, R. J. Severson, H. R. Nowicki.

V. D. Anderson Company
S & T Bldg., Booths 47, 48

Ansul Chemical Co.
Silver Lane, Booth 24

Fire extinguishers, fire trucks, piped fire extinguishing systems, specialized dry chemical fire equipment.

J. R. West, C. H. Armstrong, D. A. Watson, S. J. Decker, V. W. Murry, J. G. Vermilye, T. S. Gorman, J. C. Morgan, E. N. Gideon.

Appleton Electric Co.
Park Lane, Booth 35

Electrical fittings both explosion-proof and regular, circuit breakers, line starters and combination enclosures. Electrical switches, plugs and receptacles, pipe fittings and lighting fixtures.

Arthur I. Appleton, I. W. Strong, F. W. Wehrheim, E. V. Aldridge, W. C. Wineberg, Wade Schroeder, P. M. Darby, J. R. Chambers, H. T. White, R. Glover, M. Hamilton, J. Norris, C. Luzecky, J. King, J. Clack, M. Ogden.

Arcair Co.
Kansas Bldg., Booths 28, 29

Metal removal torches for cutting and gouging any type of metal.

M. D. Stepath, Elmer Lehmkuhl, Martin G. Boyer, W. J. Coughlin, Dude Vaught, Jerry McEvilly, Bob Coder.

Armco Steel Corporation
Block R

Armstrong Machine Works
Texas Bldg., Booth 32

Line traps (steam, liquid drain, gas relief and dual gravity) and pipeline strainers.

T. M. Reed, O. E. Ulrich, W. H. Allen, C. Bernardo, E. Kannenberg, P. Hewitt, J. Orr.

Aronson Machine Co.
Kansas Bldg., Booth 81, 82

Pipe turning rolls for welding rotating pipe, welding positioner, welding clamps.

Ned Nyberg, Mac Conine, Charles W. Dempsey.

Arrow Industrial Mfg. Co.
S & T Bldg., Booths 18, 19

Austin-Western, Construction Equipment Div., Baldwin-Lima-Hamilton Corp.
North Area, South of Block 201

Hydraulic cranes.

C. M. Lippincott, H. P. Lockart, A. M. Smith, R. C. DesJarden, E. C. Brown, G. Woolman, W. E. Chapman, E. H. Fredrickson, W. Geib, R. H. Diller.

Automobiles M. Berliet
North of Block 12

Largest truck in the world.

Paul Berliet, R. Thouin, Froissart, G. Granger, W. Lavignac, Jerry Nourry, Bernard Musnick, Blattner.

Axelson Manufacturing Co.
Block 104

B

Baash-Ross Company, Inc.
Texas Bldg., Booths 24, 25, 26

Baker Filtration Co.
Silver Lane, Booth 25

Water filtration equipment.

W. O. Baker, Beecher B. Baldwin, Jay P. Gould, Chris Kral, J. C. Velvin, Jr.

Baker Oil Tools, Inc.
Oklahoma Bldg., Booths 99 - 112

Packer milling tool, retrievable parallel packers, large-bore drillable packers, parallel and triple-string flow tubes, tubing anchors, circulating differential fill-up equipment, stage cementing collar, pack-off shoes, hammer-Lok stop rings, thread-locking compound, full-flow float valve and tubing primary cementing equipment.

T. Sutter, E. H. Clark Jr., G. D. Hall, C. M. King, R. N. Waters, J. C. Comstock, D. L. Sewell, P. E. Hilton, R. D. McBrian, C. C. Taylor, R. C. Glover, G. M. (R. C.) Anderson, J. C. Burtner, C. A. Greve, D. C. Bianchi, P. J. Strohm, C. J. Berlin, B. O. Ellington, P. H. Galbraith, W. F. Noxon, G. E. Turner, J. T. Mitchell, K. E. Hawkins, G. A. Sullivant, T. J. Singley, R. S. Bedillion, N. H. Lytton, D. C. Lewis, G. W. Mitchell, R. L. Turner, E. H. Bigelow, H. L. Hanright, K. J. Kurtz, W. S. Althouse Jr., H. H. Fisher Jr., J. R. Baker, J. F. Muse, H. K. Todee, T. L. Crowe, R. A. Kent, D. C. Preston Jr., W. D. Myers, J. D. Keithahn, E. M. Baggess, R. V. McIntire, C. J. Taylor, H. W. Pullman, E. F. Hannon Jr., J. F. Szepanek, W. C. Wilson, I. J. Teitelbaum, P. de Garay, R. K. Hautzinger, L. R. Thorne, M. O. Anderson, J. E. Cox.

Band-It Company
Oklahoma Bldg., Booths 82 - 129

B and W, Inc.
Park Lane, Booth 2, 3

Primary cementing tools, scratchers, centralizers and stop collars.

Bruce Barkis, K. A. Wright, J. R. Solum, L. D. Styles, Jr., Frank Richardson.

Bantam Bearings Div., The Torrington Co.
Oklahoma Bldg., Booths 177, 178

All types of bearings: anti-friction, self aligning, spherical roller, tapered roller, needle roller, radial roller, ball radial and roller thrust; self-aligning ball bushings for controls and linkages, and retainer-equipped needle roller bearings.

J. H. Williams, W. F. Shotola, J. A. Toth, J. W. Casteen, George Ging, R. E. Dunkle, G. W. Weiss, alter Fisher, G. E. Marvel.

Barco Manufacturing Co.
Kansas Bldg., Booths 83, 84

Ball joints, swing joints, flexible struts and hydraulic vibration snubbers.

J. O. Heyworth, F. M. Moore, R. T. Clary, R. G. Pitcher, A. A. Vanderveen, J. E. Callahan, J. A. Wigren, L. R. Bromley.

Baroid Division, National Lead Co.
Oklahoma Bldg., Booths 83, 84, 127, 128

Drilling fluid products, chemicals; mud logging services; world map showing company operations; drilling fluid testing equipment; formation samples from all over the world viewed through microscope; hospitality facilities.

George B. Coale, Amos A. Roberts, Dr. George R. Gray, Ben R. Bourland, Leon W. Huebel, Jack H. Beesley, J. W. "Tiger" Hood, B. L. Boccella, F. A. Christanelli, Charles A. Bryant.

John Bean Division — Food Machinery & Chemical Corp.
Texas Bldg., Booth 8

Salt water disposal pumps, core drilling pumps, secondary recovery pumps, high pressure reciprocating pumps, inside packed and outside packed reciprocating pumps, stainless steel reciprocating pumps, low capacity-high pressure mud slurry pumps, chemical processing-high pressure reciprocating pumps, high pressure jet washers, high pressure fog fire fighter trucks and equipment.

Frank C. Kluiber, James Pryor, James Morrow, Bud Sampley.

Beckman Process Instruments Division
Texas Bldg., Booths 49, 50

Beech Aircraft Corporation
West Area, Block 123

Bell Corp.
Silver Lane, Booth 12

Automatic drilling controls and mud weighing device.

Leo A. Bell, J. L. Barnett, R. E. Hudson, A. G. Chandler, W. A. Harries.

The Bellows Company
North Area, Booth 4N

Bendix Aviation Corporation
Kansas Bldg., Booths 34, 35, 36

Bendix Aviation Corp., Scintilla Division
Oklahoma Bldg., Booths 9, 10

Low tension magnetos, transformer coils, and ignition cable assemblies for spark-ignited industrial engines, diesel engine fuel injection equipment and electrical connectors.

Paul Campbell, J. T. Davidson, Frank Dilley, Dave Downin, M. C. Gilbert, S. B. Merritt, A. J. Poole, Jr.

Bendix-Westinghouse Automotive Air Brake Co.
North Area, Booths 74, 75

Air brake systems and air control devices for trucks, buses, trailers and allied equipment and a driver reaction and braking distance timer.

R. E. Coughenour, G. Brogdon, L. Henze, J. Gibb, J. E. Jardine, W. H. Parish, O. Lucy, G. Youngblood, A. B. Collinsworth, C. A. Wachtler.

Berry Hydraulics
Oklahoma Bldg., Booth 39

Bestwall Certain-Teed Sales Corp.
North Area, Booth 7N

Bethlehem Steel Co.
Silver Lane, Block 9

A complete drilling rig: drawworks, level drive power compound, diesel engines, hydraulic torque convertors, combination rotary drive unit, coring and sand line reel and catheads driven by a diesel engine with a hydraulic torque convertor, remote control console unit, slush pumps, rotary table, crown block, traveling block, swivel, substructure, derrick. Complete line of: swivels, rotaries, traveling blocks, crown blocks. Pumping units, general service pumps. Drilling rig operating in water circulation service, first rotary drilling unit. Well checkers, meters, metering separators, dehydrators, engine-compressor unit. Pipe, wire rope, sucker rods and fasteners, fabricated steel, forgings. Simulated typical oil field supply store. Model waterflooding plant installation.

H. L. Hawkinson Jr., Art Weber Jr., F. R. House, L. V. Nowlin, R. O. Branyon, W. J. Brady, H. V. Harder, L. A. Myers O. H. Crowe, W. T. Davis, J. G. Floyd, T. C. Graham, R. A. Johnson, E. S. Lewis ,C. R. McNair Jr., E. R. Phillips, G. B. Sager, W. E. Stephenson, W. J. Vark, M. R. Griffith, R. F. Landry, W. R. Hempkins, I. E. Hood, C. W. Blackstun, R. A. Blair, J. A. Buland, J. J. Caskey, R. M. Cox, R. H. Gault, Jay Massey, C. E. Medley, Austin Moore, B. L. Morgan, Jr., R. J. Moss, W. A. Nestlerode, Harold Perry, H. E. Redden, R. W. Rhoden, B. D. Robbins, L. K. Roberts, D. G. Shank, J. C. Watts, Wendell M. Jones, J. R. B. Freeman, H. W. Robinson, Walter A. Kropf, R. B. Dearing, N. W. Kessler, L. T. Matuszewski, T. W. Armstrong, J. W. Atkins, R. S. Barnes, O. E. Berg, J. P. Brosnahan, R. E. Burns, J. N. Castner, N. R. Downie, E. H. Gumbart, W. B. House, R. F. Hurst, O. W. Johnson, W. W. Johnson, G. LaSchober, J. D. Morrison, B. G. Ramage, D. C. Steele, L. A. Stoppel, D. F. Taylor, F. E. Tuxworth, K. C. Winston, C. M. Haas, A. A. Havelin, J. R. LeCron, L. C. Leprohon, C. Nagy, A. Schwartz, E. J. Walker, S. A. Wilson, J. S. Worth.

Bethlehem Supply Company
Block 9

Bettis Corp.
S & T Bldg., Booth 60, 61

Valve actuators, automatic plug valve lubricators, chemical injectors, spinning chain, chain tongs.

John M. Sheesley, W. N. Bitterman, Vernon Reaves, N. D. Christmas.

The Bettis Rubber Company
Park Lane, Booth 1

Big Three Welding Supply Co.
Oklahoma Bldg., Booths 189, 190

BJ Service, Inc.
Toland Dr. & Redwater Rd., Block 204

Fracturing pump truck, cementing pump truck, high speed triplex ram pump, casing floating equipment, retrievable casing packer and jet perforator.

J. B. Merritt, R. G. Miller, W. T. Box, A. M. Birnie, M. B. Riordan, J. V. Derrick, G. M. Davis, C. C. B. Moody, V. C. White, Jim Rominger, B. L. Crone, C. R. Cross, L. H. Kaltenberger, J. T. Streger, C. Z. Hughes, R. P. Maddox, J. C. Jackson, R. H. Jackson, E. M. Cloughly, W. S. Pate, Vic White, T. S. Lancaster, R. P. Kirkpatrick, C. F. McMahan, E. C. Kendall, W. E. Sonnamaker, B. B. Caldwell, B. L. Woods, C. W. Haskew, F. W. LeVier, S. A. Maley, Chas. Moore, C. T. Gray, E. M. Syverson, G. G. Lasater, C. A. Wallace, C. B. Paine, E. C. Efaw, A. N. Graff, C. H. Rose, Herb Alexander.

Black, Sivalls & Bryson, Inc.
California Bldg., Inside Exhibit
North Area, Outside Area, Block 208

Gas mass flowmeter, gas processing equipment, fiber glass tanks, lease automation equipment, control valves, safety heads.

K. W. Lineberry, H. A. Ruysser, C. H. Myers, Floyd C. Myers, Lee Kelton, Ralph Stevens, J. E. Byers, Harold Ebeling, J. E. Darr, John H. Raidl, T. E. Pool, Vern Palmer, Ed Reif, John Cross, Glenn Bradford, John Williams, James Lee, L. E. Jones, E. C. Rhodes, William Lacy, E. L. McCarthy, M. Steve Worley, Dr. E. C. Young, Harry Johnson, Ed Moses, J. Roger Heumann, L. M. Tidd, Carlos F. Lavenas, Howard Anderson, Paul Bartley, Delbert Smith, Gordon Hougestol, C. R. Bootz, R. H. Wheeler, A. R. Huse, Don Lin.

Blackhawk Mfg. Co.
North Area, Booth 76

Hydraulic jacks, hydraulic tools, hydraulic bending equipment.

Wes Kiley, Paul Moore, Norm Card.

Bonney Forge & Tool Works
Oklahoma Bldg., Booths 32, 33

Welding fittings, forged steel screwed and socket welding tees and elbows. A forged, integrally reinforced, insert butt welding pipe fitting specially designed for application on high yield pipe.

Alonzo L. DeCell, Winston M. Hudson, Joseph M. Potts, Wm. M. Jackson, George A. Hart.

Bos-Co. Equipt. Engineering & Mfg.
North West corner of Block 208

Engine starters, pipe anchors, strainers, packaged surface pump units, guard rails, chemical injectors, plastic paint and plastics.

Walter Beal, LeRoy Bossard, A. M. Buxton, C. E. Coburn, Fred Niemeier, Clyde Small, O. E. Watson, Dan Byrne.

The Bovaird Supply Co.
Bldg. on Drake Drive

Drawworks, slush pumps, rotary tables, swivels, blocks, hooks, tool joints, drilling bits, pumping units, sucker rods, water flood pumps, well head equipment, deep well pumps and working barrels, valves and fittings, and mechanical rubber goods.

D. D. Bovaird, R. G. Ayers, R. E. Batchelor, Thomas H. Trower, W. J. Bovaird, T. C. McCuistion, C. F. Hamm, F. J. Robbins, J. E. Goodell, J. W. Youngling, R. L. Fogel, F. D. Moore, W. F. McIlvain, R. W. Robbins, Ralph T. Enloe, W. F. Robertson, R. E. Whitten, J. R. Kennedy, J. L. Price, F. H. Rudrauff, E. M. Henson, S. J. Mead, O. C. King, L. C. Hathaway, Lyle Galbraith, Fred Bursott Jr., B. D. Price, J. B. Martin, M. M. Quinn, G. D. Sell, R. T. Hayes, Gentry Adams, R. F. Kercher, M. L. Sutton, J. L. Smith, J. B. Vaughan, Paul M. Brown, L. A. Davis, J. C. Phillips, J. B. Hubbard, T. B. Pierson, J. R. Bonner, J. C. Wilkinson, J. R. Shoemate, R. B. Reeves.

Bowen-Itco, Inc.
Block V

Bowser, Inc.
North Area, Block 205

Bradford Motor Works
Weight indicator, well servicing unit, supply store exhibits.

G. B. Morris, H. T. Morris, L. L. Thomas, S. E. Corry.

BrakeSol, Inc.
S & T Bldg., Booth 78

Paraffin treating chemical methods of use for controlling paraffin in oil production and transportation, methods of reclaiming tank "bottoms" from large production, pipeline and refinery tanks, methods of controlling paraffin in gathering lines and pipelines.

Lester P. Brake, Harvey D. Lowe, Buford Cranford, Pat Curtin, Bill Ramsey Cecil Blackwell, Dane Greer, Harry Morgensen Bob Campbell, Ray Petete, E. W. Davidson.

Branson Instruments, Inc., Branson Ultrasonic Corp.
Silver Lane, Booth 17

Resonance thickness testers, pulse flow detectors, cleaning equipment.

D. J. Evans, E. F. Potts, F. W. Hightower.

The Brewster Company, Inc.
Block 10

Briggs & Stratton Corp.
Oklahoma Bldg., Booths 13, 14

Ralph N. Brodie Company
California Bldg., Booth 54

Brown Instruments Division of Minneapolis Honeywell Regulator Co.
S & T Bldg., Booths 41, 42, 43

Brown Oil Tools, Inc.
Texas Bldg., Booths 59, 60

Charles Bruning Company, Inc.
Kansas Bldg., Booths 62, 63

Bucyrus Erie Company
Block 4, Block 1E

Rotary exploration and seismograph prospecting drill, servicing rig, new 45-ton transit crane, ¾-yd hoe.

H. M. Jameson, G. D. Grayer, S. A. Stone, C. F. Parthum, M. B. Jaeger, K. E. Albrecht, E. T. Goree, Paul Thiel, V. C. Mickle, W. G. Piper, R. E. Cannon, H. R. Langford, G. E. Ponder, J. D. Finley, C. E. Stewart, T. R. McElhatten.

G. T. Bynum Co.
North Area, South of Block 204

Hydraulic pipe straighteners, jacks and presses.

G. T. Bynum, G. T. Bynum, Jr., C. O. McWhorter.

Byron Jackson Company
Oklahoma Bldg., Booths 208 - 210

C

Cabot Shops, Inc.
Block F, Block Z

Air balanced and beam balanced pumping units.

R. A. Baker, Rue Hestand, Berton Doucette, George Eyler, John Neighbors, Roy Grigsby, Paul Slonaker and Thad Boadway.

Cal-Metal Pipe Corp. of La.
Kansas Bldg., Booth 80

Camco Incorporated
Oklahoma Bldg., Booths 198 - 200

Cameron Iron Works, Inc.
Outside North Door of Oklahoma Bldg.
West Area, Block 115

C & D Batteries, Inc.
S & T Bldg., Booth 72

Cardwell Manufacturing Company, Inc.
Block Q, Block R, Block N

Caterpillar Tractor Co.
Seminole St., Oklahoma City Ave.,
Hobbs St. and Mid Continent Dr.

Crawler tractors, pipelayers, diesel engines.

W. K. Cox, W. S. Zeigler, K. F. Ames, F. D. Haberkorn, J. W. Mohler, J. J. Valentine, G. E. Burks, J. E. Jass, L. L. Morgan, F. V. Jacobs, J. J. Keyes, R. D. Evans, J. Radomsky, J. A. Cobb, H. D. Clark, H. L. Winn, D. C. Reynolds, C. R. Fahnestock, C. A. Meurn, M. E. Fearis, C. B. Rians, H. W. Siebels, D. L. Penwell, J. E. Roberts, J. Cook, K. S. Spiekerman, C. H. Johnson, D. W. Turnbull.

Cemco Industries, Inc.
Kansas Bldg., Booth 31

Central Plastics Co.
North Area, South of Block 202

Insulated flanges and unions, gas meter swivels and pavement inserts for gas leakage surveys.

Riley E. Harmon, Ann Harmon, W. F. Schick Jr., Joan E. Schick, Melvin Ede.

Cessna Aircraft Company
East Area, Block 2E

Chain Belt Company
Texas Bldg., Booths 99, 100, 111, 112

Cherokee Steel, Inc.
North Area, Block 205

Gas compressor package, refinery vessel special plate steel, LPG products, pipeline sampler, LACT unit, lost circulation (drlg mud) material, building material.

M. C. Bolin, Jr., Lee D. McElroy, Bill Wood, Harold Robinson, Dan Smith, Jack Woods, Ken Fisher, Dave Clark, Jerry Cunningham, Dub Corley, Gene Fowler, Chas. Sheppard, Les Beihl, Roy Cassel, Bud Purswell.

Chicago Bridge & Iron Company
Texas Bldg., Booth 85, 125

Oil storage tanks and processing equipment.

D. A. Leach, A. R. Simpson, John Horton, D. E. Stephan, S. C. Hamilton, W. J. Sward, E. N. Zimmerman, T. F. Cocks, F. E. Lee, H. C. Minter, E. P. Shelton, J. Q. Thomas, R. L. Blandford, W. E. Busse, H. B. Funderburk, Jr., K. W. Lange, W. H. Woleben, J. R. Mansell.

Chicago Pneumatic Tool Co.
Silver Ln. & Skelley Dr., Block W

Rock bits, reaming bits, stabilizing reamers, drill collars, subs, tool joints, junk baskets, rotary portable compressors and Trenchdrils, impact wrenches, demolition tools, tube rollers, chippers, scalers, grinders, wire brush machines, riveters, rivet busters. Pictoral presentation of refinery, pipeline and gathering compressors; also gas driven engines for pipeline pumping stations and rig drives.

G. J. Coffey, T. P. Harris, J. B. Tiffany, J. S. Andrew, R. L. McGrew, C. L. Benedict, N. P. Donaldson, L. W. Palmer, K. K. Sweeney, D. G. Reeder, C. L. Bush, A. T. Chamberlain, B. E. Hickman, R. L. Smith, F. R. Flynn L. K. Hubbard, W. R. Merkle, F. G. Binger, E. N. Carlson, J. A. Dentinger, W. E. Tucker, W. S. Sease, G. A. May, J. D. Steen, Benny Ray, D. P. Tarpenning, J. B. Coulter Jr., Emory Green, J. C. Crowe, N. E. Little, V. L. Ash, J. B. Curtis, T. H. Tefertiller, M. L. Petty.

Chiksan Company
Texas Bldg., Booths 108, 109, 110

Will illustrate drilling product applications with a 11-ft working model drilling rig; will show working models and a color film of tanker loading systems; swivel joint for cementing services; model tank car loading rack.

H. J. Hagn, L. J. Smith, E. T. Landgraff, G. M. Bagnard, E. N. Thomas, J. L. Emerson, Frank Wiegand, Chuck Holcomb, Jack Runnells, L. L. Durkin, Henry Roessler.

Christensen Diamond Products Co.
Silver Lane, Booths 1, 2

Diamond drilling and coring bits, rubber sleeve core barrel and core samples.

W. I. Harris, James Whitaker, E. M. Jenkins, Clyde L. Anderson, Joe H. NeVille, Bob Barron, Claude J. Cox, Jr., C. Ray Hudson, Hugh G. Gunn, Peter Haught, Lloyd Maltbie, Ross D. Jackson, Charles McKnight, Robert J. Dyar, A. R. Adams, Forrest Sadler, John D. Fry, Don D. Jelinek, Ted N. Clanton, John A. Pecenka, James Cruickshank.

Chromium Plating Company
Kansas Bldg., Booth 25

Clark Equipment Co., Construction Machinery Div.
Block 119

Tractor shovels, tractor dozers, tractor scrapers, cranes, pipe handlers.

Clarence E. Killebrew, M. Lowell Conrad, Paul McAdams, Colin C. Kennedy, Alvin E. York, Wendell V. Richards, Gust J. Schwanke, Walter E. Ross, I. J. Gibson, Joseph L. Dorfler, Charles L. Ellis, Parry Barnes, B. Frank Reach, Jr., John A. Allsup, John Horton, Dudley A. Burnett, Orland K. Noel, Fred Dolton, Marshall O. Nystrom, John A. Halleran, M. J. Harrison, Devereux W. Pedley, Clarence E. Zermer.

Clayton Mark & Company
Oklahoma Bldg., Booths 51, 52

The Cleveland Trencher Co.
Block P

Trenchers, ditchers, backfillers and side-cranes.

V. S. Penote, J. A. Penote, C. P. Morgan, F. J. Fetzner, D. U. Elscott, J. N. McLeod, F. L. Good, J. W. Beaver, E. J. Kysela, E. T. Ward, D. H. Hespen.

Clevite Corporation, Texas Div.
North Area, Booths 32N, 33N, 34N

Clinton Engine Corporation
Triangle, Block 104

Colorado Fuel & Iron Corp.
Oklahoma Bldg., Booths 162 - 165
Continental Emsco Co.
Block 6, Block 7, Block 8

Continental Motors Corp.
Outside, Block P

Internal combustion power units (diesel, gas, gasoline, butane, propane).

C. J. Reese, Earl C. Ginn, C. W. Johnson, C. M. Bellinger, Peter Altman, P. C. Chamberlain, Frank Shanahan, F. E. Hanes, R. L. Hergert, W. D. Conrey, Les Pfost, W. J. Neilon, E. L. Lawson.

Continental Products of Texas
Texas Bldg., Booth 45

Water treating chemicals, water treating equipment, gas treating equipment.

John J. Sims, Wayne King, Dan Hemphill, Walter Fletcher, Ray Gilles.

Continental Tube Co.
Park Lane, Booth 26

API seamless oil country tubing and casing, special corrosion resistant intergral joint oil well tubing and casing.

Andre A. Crispin, J. Zoltowski, D. M. Portugal, C. E. Williams.

Control Panel Corp.
North Area, Booth 37N

Model 4 well lease to demonstrate automatic programing, testing and custody transfer with punched tape, strip chart and printing readout.

H. A. Hart, F. Brietze, N. R. Leatherwood.

Cook Machinery Co., Inc.
Texas Bldg., Booth 38

Laundry washers, laundry dryers, laundry extractors, on the premises laundries equipment.

W. L. Barton, A. L. Boylan, W. W. Kaehler, J. M. Cook, G. E. Pitchford, H. G. McWhirter.

C. Lee Cook Co., Div. of Dover Corp.
Texas Bldg., Booths 51, 52

Direct cooled high pressure packings, piston rings, non-metallic valve plates.

Wm. H. Barnes, C. T. Duke, G. B. Gilliam, C. J. Kremer, P. W. Mettling, J. E. Scoggan, W. W. Woobank.

The Cooper Bessemer Corp.
Block G

Fred E. Cooper, Inc.
Texas Dr. at Arcade Way, East ½ Space A, all of B and D

Oil well servicing, workover, and drilling units; and oil well pumping engines.

J. W. Allen, Harry R. Kramp, W. S. Jacobsen, Reg Cadman, Harry Farmer, Al V. Honstain, John Jacobsen, Ray Kaib, Bernie Maslaulea, Joe McKay, John Newman, A. L. Oliver, Bill Raney, Jim Toombs, Joe Williamson.

G. A. Cotten Co.
S & T Bldg., Booth 7

Pipeline scrappers.

G. A. Cotten, Frank F. Cotten, John O. Walsh, Harry Arnhols.

Coynco Products, Inc.
S & T Bldg., Booths 63, 64

Crall Products, Inc.
North Area, Booths 50-N, 51-N

Paraffin scrapers, polished rod clamps and all purpose hand cleaner.

A. E. Hickman, Judson A. Wells, J. W. Gordon, Jr., W. H. "Bill" Chapman, Fred Niemeier, Walter Beal, Eddie Rose, John Stringer, E. E. Spicer, W. J. Myers, Le Roy Mitchell, Vaughn Darnell.

Crane Co.
Oklahoma Bldg., Booths 196, 197, 254, 255

Valves and fittings.

W. O. Brown, W. B. Gilmour, V. Kornhaus, S. D. Rose, A. H. Hahn, T. S. Jones, A. J. Norre, C. H. Lovelace, R. A. Henrickson, G. Caveness, J. Carrara.

Crane Carrier Corp.
North Area, Block 205

Crane Packing Company
North Area, Booths 17N, 18N

M. J. Crose Mfg. Co., Inc.
West Area, Block 116

Crose-Cinch pipe bending machines and Crose-Littleford pipeline coating kettles equipped with Crose Trac-wheels; Crose-Wadsworth rock ripper; Crose cleaning and priming machines, coating and wrapping machines, internal and external pipe line-up clamps, road boring machine, pipe cutting and beveling machine, and a full line of auxiliary tools, materials and supplies for pipeline construction and maintenance.

Clare G. Miller, T. J. Behrenfeld, John Brand, Jim Chance, Ben C. Montgomery, Dave Wagner, W. H. Royal, John H. Manley, Harry Morris Jr., Dave Culley, Paul Evans, Buddy Davis, Tim Morgan, Hap Jones, George Limb, Bill Handwerk, Estill Sherrill, Kenneth Brockett, Kenneth Bass, L. D. Praytor, Trent Avera, Eddie Clavin, R. G. Goekler, M. L. Hollifield Jr.

Cummins Engine Co., Inc.
East Area, Block E

Diesel engines, 60-600 hp.

C. R. Boll, W. D. Blizzard, G. W. Stevens, R. S. Doxsey, R. S. Bowie, B. C. Sears, R. W. Franck, C. J. Wilhite, T. J. Paxton, J. D. Gatten.

Cummins Sales & Service, Inc.
Block 13

W. H. Curtin & Co.
S & T Bldg., Booths 79, 80

Automatic distillation apparatus, automatic flash point apparatus, hydrometer carrying case, paleontological sample washer, laboratory furniture, carbon determination apparatus, pyrex glass sink traps, heating jackets for lab use, electro-polarizer, laboratory glassware, laboratory porcelain ware, reagent chemicals, laboratory needle valves, thermometers, ASTM oil colorimeter, pH meter, centrifuge, laboratory ovens, Curtin centrifuge, balance table, tank thermometers, moisture balance, balances, color analyzer.

K. H. Clough, Roy Hayes, Charles Hinshaw, O. L. Patrick, H. H. Childress, Fred Scott, Joel Griffin.

Curtiss-Wright Corporation
North Area, Block 202

D

Darling Valve & Mfg. Co.
Oklahoma Bldg., Booths 113, 114

Valves, valve cups, seating cups, pump cups and pistons.

C. H. Simon, T. C. Jester, D. F. Sable, H. B. Foster, M. W. Hartman, F. E. Backus, M. S. Evans, D. R. Young, H. G. Menefee, R. W. Pullen, R. F. Heath, S. C. Brown, D. W. Lenzer, W. H. Atcheson, H. O. Young, W. H. Ashworth, H. A. Sumrell, J. T. Cowan.

Davey Compressor Company
West Area, Block 122

Davey, Paxman & Company, Ltd.
North Area, Block 205

Dayton Rubber Mfg. Co.
Oklahoma Bldg., Booths 211 - 240

De Laval Steam Turbine Co.
Texas Drive, Booths 8, 9

Denison Engineering Company
Kansas Bldg., Booths 23, 24

The Dia-Log Company
S & T Bldg, Booths 26, 27, 28

Diamond Chain Co., Inc.
S & T Bldg., Booths 11, 12

Roller chains, sprockets and couplings.

G. E. Schlott, H. N. Cottingham, D. R. Hodges, A. S. Baston, J. E. Cooper, J. L. Wamsley, C. O. Sundberg, F. R. Gray, G. Benko, B. K. Sollars, H. E. Morrow, E. F. Badger, T. E. Turner, W. M. Horner, R. C. Fisbeck, G. W. Allen, R. E. Kessler, L. L. Connell, R. S. Culley, B. R. Graves, C. L. Sargeant.

Diesel Energy Corporation
North Area, South of Block 201

Eugene Dietzgen Company
Oklahoma Bldg., Booths 235, 236

Double Seal Ring Company
California Bldg., Booth 52

The Dow Chemical Company
Silver Lane, Booth 26

Dow Corning Corp.
Kansas Bldg., Booth 33

Silicone electrical insulation, silicone defoamers and silicone maintenance and temperature indicating paints.

Max Leavenworth, Douglas Layne, Charles Todd, Chester Currie, William May, John Hellgeth, Donald Francisco, Edward Haire, Ted Goldmann, George Kachajian, Donald Kauppi, Robert Kroeger.

Dowell Division of The Dowell Chemical Co.
Opposite Cafe de Petrol; Block "Y"

Services and equipment for oil well acidizing, formation fracturing, cementing plus industrial cleaning. Special services and bulk products. Two chemical laboratories in operation; one for research and one for analytical. Over 200 chemicals used in various services, and Dowell's first field service unit and the newest. Sonar calipers, cement densitometer, corrosion rate tester, plus a gallary of art depicting oil's history.

John G. Staudt, W. E. Reardon, D. E. Ramsey,

B. E. McCann, A. C. Polk, R. H. Smith, W. W. Love, P. E. Fitzgerald, C. J. Steward, W. N. Estel.

Dresser Engineering Co.
S & T Bldg., Booths 39, 40

Scale model of a modern refrigeration gasoline plant.

L. L. Dresser, C. P. Stanley, A. B. Richert, W. E. Kinnebrew, B. G. Thacker, J. W. Pearce, J. S. Turley, Gillmore Langworthy.

Dresser Mfg. Div., Dresser Industries, Inc.
Dresser Industries Bldg.

Pipeline fittings and accessories, pipe couplings, pipe repair devices.

F. G. Fabian, C. Kuhn, E. R. Carey, J. Lord, W. Rowell, W. Krueger, M. C. Cleland, Ed Stafford, Henry Peebles, S. Brown.

Drilco Oil Tools, Inc.
Texas Bldg., Booth 27

Drill collar stabilizers, rotary reamers, torque indicators for drill collars, and drill collars.

Stanley Moore, Bill Bachman, Moak Rollins, Don Morris, Joe Hibler, Bill Garrett, Gene Wyatt, Jim Richardson, Carl Williams, Archie Broadrick, Bill Frietag, Sam Brown, Joe Wilson, Dick Norton, Glenn Chance, Chas. Elder.

Drilling Equipment Mfg. Co.
California Bldg., Booths 26, 27

Drilltrol
North Area, Booth 83N

Drill collar, stabilizers.

Norman D. Jaques, Jack I. Middleton, Bob Pearson, W. G. (Bill) Nutto, Tom Martin.

Duff-Norton Co. and its Coffing Hoist Div.
Oklahoma Bldg., Booth 155

Oil field jacks, mechanical jacks, hydraulic jacks, hand chain hoists, ratchet lever hoists, and electrical hoists.

T. W. Krueger, "Mac" Kelly, Ray Doan, H. E. Flood.

Bob Dunning-Jones, Inc.
Park Lane, Booths 18, 19

Durametallic Corp.
Oklahoma Bldg., Booths 261, 262

Mechanical seals, flexible metallic packings, oil circulating systems for stuffing boxes, flexible handled packing tools.

Roscoe R. Smith, R. W. Janes, Frances Smith, L. S. Gregory, Lorin W. Pflug, R. R. Branch, H. A. Walbridge, Joe Leath, Dick Walker, Allison Walker, A. R. Allison.

D-X Sunray Oil Company
Kansas Bldg., Booths 47, 46, 58 ,59

E

Eastman Oil Well Survey Co.
S & T Bldg., Booths 44, 59

Oil well surveying tools and instruments.

H. John Eastman, C. A. Brokaw, S. S. Roszel, Wayne M. Sutton, H. R. Benson, Virgle R. Graham.

Eaton Mfg. Co., Axel Div.
North Area, South of Block 202

Mobile display of heavy duty truck axles, tandem axles, double reduction axles, single speed axles and allied products.

C. D. Christie, J. R. Bartholomew, R. K. Nelson, R. Ruggles, B. Hubbell, G. Vollmer, G. Griffin.

Eclipse Fuel Engineering Co.
North Area, Booth 71-N

Flowmeters, flowmeter switches.

A. D. Wilcox, J. H. Sands, E. Hirschberg, J. M. Quick, A. L. Westburg.

Eggelhof Engineers, Inc.
Oklahoma Bldg., Booths 169, 170

Heat exchangers, heater-treater temperature regulators, compressor temperature regulators, waterflood filters, separator drain traps, rotating equipment safety shutdown switches.

Bob Molnari, T. H. Pierson, Al Jones, Cliff Lindsey, Henry Turner, George More.

Eisenwerk Wulfel, Hannover-Wulfel (Western Germany)
Open Air Stand 202

Truck mounted well servicing unit, API gear box and pumping units.

Elliott Company
Oklahoma Bldg., Booths 125, 126

Testing of large induction motor, display of explosion-proof integral hp motors, tube expander (for heat exchanger, boiler or condenser tubes), tube end trimmer and de-burrer, power-recovery process gas turbine-compressors.

C. F. McGinnis, A. L. Crichton, Philip Scarola, H. A. Bach, Ray Kline, J. N. McClure, Basil James, Hank Williams.

Emerel Manufacturing Co., Inc.
Oklahoma Bldg., Booths 60, 61, 62

Automatic top engine cylinder lubricating system.

William C. Pierce, Daniel Koppele.

Enardo Mfg. Co.
Oklahoma Bldg., Booths 257, 258

Engineered Oil Tools, Inc.
Oklahoma City Ave. & Hobbs St., Block G

Hydraulic pumping units.

Blaine Johnston, Ed Williams, P. E. Meier.

English Electric Export & Trading Co., Ltd.
Park Lane, Booths 13, 14

Ensign Carburetor Co.
Booth 194

Natural gas and LPG carburetion units.

R. P. Ensign, H. W. Ensign, R. G. Abbott, L. B. Scott, G. W. Keller, C. Brumfield, P. H. Siebert, L. Durkee, L. G. Smith, J. Miller, A. J. St. George.

Equipto
North Area, Booths 47N, 48N

Ethyl Corporation
Kansas Bldg., Booths 127, 128

Evis Petro-Fluid Corp.
North Area, Booths 91N, 92N

Petroleum fluid conditioners.

D. F. Payte, A. N. Wells, Joe L. Brown, Bill McClung, Rex McFall, Ed. T. Fecteau.

F

George E. Failing Co.
Silver Lane, Booth 10

Portable rotary slim hole and exploration rigs, related supplies and equipment.

Robert M. Greer, E. L. Alexander, Arthur Johndrow, Everett Carley, Walt Buller, H. J. Godschalk, Jimmy Helton, Dick Miles, Pete Martin, Bud Floyd, John McMahan, Jack Felton, Burt Pedigo, Wesley Page, Geo. Doremus, H. Holden, Don Toben.

Fairbanks, Morse & Co.
North Area, Block 203

Fawick Airflex
Texas Bldg., Booths 53, 54

Femco, Inc.
Kansas Bldg., Booth 17

Circuit scanners and telemetering equipment for remote automatic control and indicating, demonstrated by working model of oil field recovery process.

J. W. Bauer, N. F. Agnew, H. G. Hall, D. E. Driscoll.

Fenway Machine Co., Inc.
North Area, Booth 40

Portable electric and pneumatic metal cutting tools.

Joseph Yermish, James Mancini.

The Firestone Tire & Rubber Co.
West Area, Block 117, Rocky Mt. Rd. and Permian Basin Plaza

Stave and truck mounted tanks, fabric tanks, pneumatic equipment handling rollers, and special vehicle tires.

Reed Chunn, W. L. Klingman, D. L. Weihe, G. B. Harr, R. L. Bowen, L. P. Parkinson, E. J. Mara, E. A. Glass, D. C. Cline.

First National Bank & Trust Co.
North of Office

Fisher Governor Co.
Texas Bldg., Booths 76, 135

Automatic well head choke and control unit, Diaphragm and piston control valves, Electro-pneumatic positioner and transducer.

J. W. Fisher, P. A. Elfers, G. F. Brockett, N. J. Hatter, T. B. Burriss, J. F. Gaskill, B. K. Rector.

The Edwin H. Fitler Co.
Texas Drive, Booth 4

Manila marine rope, nylon rope, manila cathead line, spinning line, and derrick line, polyethylene rope and synthetic products.

James A. England, Charles G. Krpec, H. Hamscher, Jr.

Flint Steel Corporation
Oklahoma Bldg., Booths 80, 81

Display using fabricated steel in unusual designs, supporting pictures of installations.

C. W. Flint, Jr., H. G. Lewis, C. B. Gannaway, Jr., W. P. Kissinger, W. B. Faulkner, S. J. Harshman, T. D. Weir, J. B. Billingsley, W. F. Hubbell, Wayne Lawson.

Flo-Bend, Inc.
Kansas Bldg., Booth 78

Fluid Packed Pump Co.
Oilmaster Bldg., West of Main Gate, Lot 13

Subsurface oil well pump equipment including rod-drawn pumps, hydraulic pumps, artificial lift equipment for dually completed wells, and pump accessories.

Sidney Shuman, D. H. Vandenberg, J. R. Brennan, D. S. Allen, P. S. Bloudoff, Bill Bonner, J. T. Clements, L. W. Crow, R. V. Holton, L. C. Jones, V. S. Lewis, B. L. Miller, J. J. Moran, C. D. Newbolt, G. R. Newbolt, H. H. Palmour, G. W. Peters, W. Satterwhite, A. G. Simpson A. L. Smith, J. A. St. John, M. C. Watkins.

Fluid Power Corp.
Oklahoma Bldg., Booth 28, 29

Hydraulic drill pipe and casing tongs hydraulic pump, motors and control panels.

J. S. Montgomery, W. C. Hutton, F. R. White, R. K. Cooper.

Fo-Mac Enterprises, Inc.
Park Lane, Booth 30

Ford Division (Fleet Sales Dept.)
Booth 6E—SE corner of exhibition grounds

10 truck chassis with special bodies and equipment installed, 11 industrial engines and power units, 3 industrial tractors with special oilfield equipment installed.

A. C. Scott, H. W. Cook, I. L. Pierce, Howard Pickard, Charles Elder, W. K. Hamilton, N. A. Gruber, J. F. Bachman, L. E. Henn, L. H. Lesperance, Frank Conover.

Foster Cathead Co.
Texas Bldg., Booths 12, 13

Foster Engineering Company
North Area, Booth 88N

The Four Wheel Drive Auto Co.
Block N, East of Block N

Fram Corporation
California Bldg., Booth 49

France Packing Company
Texas Bldg., Booth 72

Franklin Supply Co. & Franklin Pipe & Supply, Ltd.
Block X

Outlining services offered, materials handled, and supply points of company.

Jene Harper, Larry Harper, L. H. Strouse, Burt Strouse, Ed Ferrell, Bill Carroll, Clarence Sublett, Bob Spellman, Russ Smith, Bill Kerin, Jr., Jean McIntyre, John Russell, Bill Kerin, III.

Franks Div. of Cabot Shops, Inc.
Block Z

Well servicing and workover rigs.

R. A. Baker, C. C. Simmons, W. B. Woody, Jack Reeve, Bill Barry, K. M. Lamer, John G. Leyh, Vern Alley, Bill Pitezel, Hilmer Heinritz, A. J. Rogers, Tom Stringer, Don Turner, D. M. Lawrence, Dudley Jordan.

Franks Machine Co.
Block 104

Complete air or water drilling unit, drill bits subs, and tool joints.

Joe Franks, Craig Nelson, A. W. Whitnell, Walter Schmidt, Grady Baker, Clayton Voth, Ralph Graves.

FWD Corporation
Block N

Tractor-mounted pipe layer and geophysical drill.

James A. Driessen, G. F. (Joe) DeCoursin, Lloyd Pernot, John Horton, Keith Liesch, Kenneth Jorgenson, Glen Pate, Art Laack, Ken Johnson, Warren Snider, Merton Anunson.

G

G & W Electric Specialty Co.
Silver Lane, Booth 32

Gardner Denver Company
North Area, Block 203, North of Block 10

Company's first drawworks, centrifugal type mud charging pumps, plunger type mud pumps for deep drilling, impact wrench for equipment servicing, mole-drills, waterflood pumps, steam pumps, compressors, air wrenches, air hoists, sinkers, paving breakers, tampers, multiple air drills.

Gifford V. Leece, George W. Guntekunst, R. J. Bauer, R. H. Ganz, C. M. George, D. O. Meek, Robert L. Williams, Carson L. Ruyle, Robert Heckenkamp, W. C. Vail, R. G. Caldwell.

Garrett Oil Tools, Division of U. S. Industries, Inc.
Southwest Corner, Block 104

Gas lift valves, wireline gas lift equipment, circulating valves, motor valves, relief valves, pilot controls, automatic free pistons, automatic well safety equipment, lease automation systems, automatic custody transfer systems and lease commingling systems.

D. E. Whittenberg, V. B. Scott, William J. Rapson Jr., K. J. Walker, M. V. Cline, D. M. Brock, Glen Denison, Neal Fowler, R. V. McAfee, W. K. Woodward, H. F. Boester, Ross Brewer, C. B. Sheets, Jack Conner, Charles G. Phillips, Larry Johnson, Dale Owens, T. R. Collins, L. D. Stell, Bill Burton, Bolling Abercrombie, Bob Frey, Fred Holmes, Farlin Ward, Charles R. Kemp, Bob Watson.

H. U. Garrett
California Bldg., Booth 53

Gaso Pump & Burner Mfg. Co.
Block W

Gates Rubber Company
Texas Bldg., Booths 9, 10

Gatke Corporation
California Bldg., Booths 23, 24, 25

General American Transportation Co.
Oklahoma Bldg., Booths 5, 6

General Controls Co.
California Bldg., Booths 12, 13

General Electric Co.
Oklahoma Bldg., Booths 241 - 244

General Electric Company (Carboloy)
North Area, Booth 39N

General Motors Corporation
Block 10

General Valve Company
Kansas Bldg., Booths 86, 87

The Geolograph Co.
S & T Bldg., Booth 49

Mechanical well logging equipment, automatic drilling control equipment, drift indicator recording equipment.

Paul B. Nichols, H. Travis Brown, Otto F. Thompson, J. O. Melton, W. R. Kolb, I. M. Carpenter, Travis W. Brown, A. J. Shorney, Fritz Nichols, John Ferguson, H. F. Miller, Frank High, E. B. Young, E. P. McMillon, Hugh Nance, T. A. McMillon, Ray Lovejoy, James Williams, R. G. Wise, Lamar Keith, R. B. Hunnicutt, E. L. Ross, Hap Decker, Clark Arnold, Glen Williams, E. B. Bailey, Kenneth Holder, Lloyd Stevens.

Geophysical Research Corp.
S & T Bldg, Booth 51

Global Marine Exploration Co.
Kansas Bldg, Booth 32

Photographs, drawings, slides, and movies of: Offshore floating drilling (CUSS method), marine engineering and construction, offshore well completion (under and above water), world wide offshore exploration and development.

R. F. Baver, A. J. Field, Hal Stratton, R. C. Crooke, Sr., T. W. Redin.

The B. F. Goodrich Company
Kansas Bldg., Booth 76

The Gorman Rupp Company
California Bldg., NE of

Goulds Pumps, Inc.
Oklahoma Bldg., Booths 252, 253

Oil industry pumps, new process pump.

Homer Plowman, Jack Tyler, H. McDonald, Grant Griffen, Lee Topp, R. L. Tarnow, Tom Kelley, Henry Herold, Tom Hosea, Wayne Bilbo, P. J. Olmstead, E. Schwandt.

Granberg Corporation
Kansas Bldg., Booth 30

Graver Tank and Mfg. Co.
Kansas Bldg., Booths 74, 75

LACT systems, dehydration units, oil and gas separators, emulsion treaters, fluid boosters, metering separators, field erected storage tanks.

Clark Root, J. E. Fogarty, W. B. Broxham, E. R. Fogarty, C. P. MacDonald, Henry McCabe, R. F. Millett, Jack Gray, E. G. Vail, L. G. Moreland.

Gray Co., Inc.
S & T Bldg., Booth 65

Paint spraying without air, high volume transfer pump.

Warren Turnell

Gray Tool Company
Texas Bldg., Booth 15

John A. Green Co.
Oklahoma Bldg., Booths 167, 168

Electric and electronic equipment and component parts.

Frank H. MacDonald, C. F. Lincoln, Jr., Charles S. Boyd, Kenneth C. Herrington, John A. Green.

Gripholst, Inc.
North Area, 11 N

Portable, manually operated, hoisting and pulling units.

G. L. Robinson, W. B. Greeley.

Grip-Strut Div. of Globe Co.
North Area, Booths 93N, 94N

Grip-Tite Mfg. Co.
Silver Lane, Booth 31

Grove Regulator Company
Texas Bldg., Booths 36, 37
Silver Lane, adjacent to Booth 30

Gruner & Company
North Area, Booths 24N, 25N

The Guiberson Corp.
Dresser Bldg., East end of Silver Lane

Workover and production tools. Molded rubber products.

Gordon G. Guiberson, Alex. P. Smith, Harry S. Zane, Jr., Earl W. Davis, Dennis L. McGill, Robert A. Day, Dale L. Fry, Wendell V. Phillips, Robert L. McAdams, L. E. Vessels, Tom Losey, John J. Lane, Roy C. Davis, Phil E. Pierce, Roland O. Cox, Harry E. Simpson, Morgan Crow, James E. Reagan, William Horn.

Gulf Coast Machine & Supply Co.
Park Lane, Booths 7, 8

Gustin-Bacon Mfg. Co.
Silver Lane, Booth 27

H

Hagan Chemicals & Controls, Inc.
S & T Bldg., Booths 83, 84

Hale Mfg. Co.
Oklahoma Bldg., Booth 95

Butterfly valves with electric, diaphragm and piston operators.

B. C. Hale, C. N. Vance, Jr., Wm. E. Esslinger, Ward Settle, Ted Dickerson, C. J. Baeten, Don Vossen, Harold Jarvis, R. K. Cooper, W. O. Nelson, Barney Cummings, Bill Porter, Dick Longnecker, Bill Smith, T. R. Rhodes, B. H. King.

Halliburton Oil Well Cementing Co.
Block K, East of Block K, West of Block K

H & M Pipe Beveling Machine Co.
California Bldg., Booths 50, 51

Pipe beveling machine, portable pipe bevel cleaning and land machine.

Lloyd E. Lippincott, Harry L. Stallard, M. C. Harter, Tom Seay.

The Happy Co.
Center of the Ground

Cooling equipment, pumping unit, engine starter, gas volume tank, meters, well tester, oil level control, wrist pin pusher outer, woven hose and rubber products, electric plant, air cleaner, v-belts and sheaves, well heads, tubing tee, stuffing box, polished rod clamp, adjustable crank guards, pumping motor, pumping control panel.

Paul E. Mahaffey, Leo C. King, John E. Mahaffey, Wm. C. McDonald, F. W. Robson, Walter Dorsey, C. C. Stanley, J. W. Ritter, Ed. Allan, Roy Rowe, Harold Ashworth, C. B. Mandl, Harley Price.

Harbison-Fischer Mfg. Company
Kansas Bldg., Booths 10, 11

Rod (insert type) and tubing pumps, special sub-surface pumps, ball and seat check valve assemblies and related production equipment.

Lawrence Harbison, Louis Baker, Sam Johnson, Bill McDonald, Harry Day, Rex Lawrence, Harry Young.

Hardy-Griffin Engineering Corp.
Texas Bldg., Booths 127, 128

Harley Sales Company
Block 4

Harnischfeger Corp.
North Area, Block 203

Harris Upham & Co.
Texas Bldg., Booth 7

Harrisburg Sales & Service, Inc.
Texas Bldg., Booth 96

Herb J. Hawthorne, Inc.
North Area, Booth 27N

The Haynes Co.
North Area, South of Block 201

Protective coatings, spiral and plate type heat exchangers, versators, grease hemogenizers, lube oil blenders, plastic fabrications, laboratory ware.

Dick Haynes

Hazard Wire Rope Div.
American Chain & Cable Co., Inc.
Silver Lane, Booths 29, 30

Wire rope.

H. S. Frady, Bob Cothron, Art Motl, Jim Pierce, R. C. Power.

HECO — Hardwicke-Etter Company
North Area, South of Block 204

Heidle's Portable Pipe Service

Heidle's Machine Works

Heidenbrand Tubular Service
Between V & Y on Dawson St.

Special portable equipment to service oil country tubular goods, including stress-aligning tensile testing machines.

E. A. Heidenbrand, Paul Heidenbrand, A. P. Heidenbrand, Russell Heidenbrand.

Hercules Filter Corp.
Texas Drive, Booth 10

Diatomaceous earth pressure leaf filter, circular leaf filter and pressure leaf filter with areas up to 30 sq ft.

C. E. Hunziker, H. T. Jones, Jr., Howard Hagood, E. J. Brinkmeyer, Carel van Luin.

Hercules Motors Corp.
North Area, Block 206

Hercules Tool Company
California Bldg., Booths 7, 8, 9

Stuffing boxes, duplex polished rod, tubing hangers, tubing and casing heads, stuffing box glands, polished rod clamp-off support, cross tee, pumping and flowing tee.

S. P. Tschappat, L. C. Rhoads, Walter H. Cox, Wm. H. Sage, Jr., H. K. Anderson, Thomas E. Marshall, Carl Roper, C. P. Cummings, Harold R. Jarvis, N. E. Coburn, H. J. McMann, W. W. Coonrod.

Hewitt-Robins
Silver Lane, Booths 6, 7

Hildebrandt Engineering Co., Inc.
Oklahoma Bldg., Booth 237

Pressure recorders, temperature recorders, mud or cement pressure recorder and gage, pulsation dampener, magnetic retriever.

John P. Hildebrandt, Mrs. Audrey Staker, O. J. Myklebust.

The Hilliard Corp.
Oklahoma Bldg., Booth 153

Lubrications, fuel and industrial oil filtration equipment.

T. A. Labrecque, Finley M. Steele, Lynn McGuffy, Harry Tindel, Harold B. Putnam.

Hillman-Kelley
North Area, International Ave., Block 203

Power tubing tongs, power sucker rod wench, power casing tongs, macaroni head, power units.

James H. Keeley, James C. Keeley, Fred J. Hillman, Mark C. Brown, Jr., Andrew B. Campbell, H. H. Collins, Ralph C. Snowden, Mac D. McLemore, Aubrey L. Gooden, Robert B. Cheatham, Jr., Marvin L. Judd, Wilford G. Carter, James Ray Barrett, Jr.

Don Hinderliter, Inc.
Texas Bldg., Booths 87, 88

Hoerner Boxes, Inc.
Kansas Bldg., Booth 18

Charles N. Hough Mfg. Co.
Texas Bldg., Booths 123, 124

Houston Oil Field Material Co., Inc.
Texas Bldg., Booths 18 - 21

Models of: directional drilling tools, fishing and cutting tools, sub-surface surveying equipment, rental equipment.

Leon Singleton, Bob Duke, Bob Dilworth, Lee Roy Denham.

Hughes Tool Company
Block 106

Humble Oil & Refining Co.
Texas Bldg., Booths 78, 79, 132, 133

Hutchison Manufacturing Co.
Oklahoma Bldg., Booths 147, 148, 183, 184

Shale shakers and derrick lighting systems.

F. E. Hutchison, J. E. Smith, C. R. Curtis, H. B. Cookston, Roy LaBerge, Joe Fortner.

Hydril Company
Block F

Blowout preventers, blowout preventer operating manifolds, automatic pump accumulators, casing and tubing, pulsation dampener and surge absorber, inside blowout preventers, non-lubricated plug valves.

A. I. Birch, Jr., W. W. Cathriner, H. R. Collins, Jr., I. B. Doyle, Joe Festervan, J. W. French, L E. Galligan, H. D. Gideons, J. B. Gillham, J B. Hughes, B. M. Jones, J. D. McCartney, L V. Moser, Russell McMurry, Tom Morrow, D. D. Norriss, M. E. Odum, D. L. Orr, B. J. Parham, Jack Pollock, J. W. Wade, Miller Wuslick, Earl M. Daniels.

Hydrolec, Inc.
Booth 41N

Electric bottom-hole oil well heater.

Oscar H. Hood, Jim T. Holman, Jack C. Dempsey, James K. Bivins, Lou Potomas, Del Hubman.

Hydro-Test, Inc.
North Area, Block 202

Hypro Engineering Co., Inc.
Kansas Bldg., Booths 12 13

I

Ideco, Inc.
Block 11

Complete drilling rigs, mud pumps, swivels, sheaves, pump valves, pulsation dampeners, rolling disc kelly drive, rotary table, scale models of full-view mast, Dual-Rambler rigs, full-view mast.

George W. (Jack) Walton, W. O. (Bill) Cook, Gordon G. Wilbur, E. F. (Gene) Shiels, Walter F. Born, J. R. Hilder, S. H. Barrett, Bob Brown, R. M. (Dick) Perdue, Turgut Ulug, R. A. (Bob) LaFleur, W. M. (Bill) Marks, W. K. Thorson, C. W. Harrison, S. L. Matheny, Jr., J. E. McGuire, A. L. Woracek, R. A. (Bob) Feemster, Charles Wright, Ed Kirby, Charles White, Berwin L. Price, W. J. Mallin, Lyle Hawkes, W. W. (Pat) Patterson, Clyde Bloss, C. R. (Cliff) Athy, N. W. Fowler, Ellis Williams, J. C. Young.

Indiken Company, Inc.
Park Lane, Booth 4

Ingersoll-Rand Co.
Block U

Centrifugal, rotary and reciprocating air and gas compressors, stationary and portable, centrifugal pumps, air and electric tools, air starting motors, air hoists, vacuum equipment.

N. D. Cherry, J. G. Lutz, J. J. Janzen, H. M. Fiske, H. G. Rethmeyer, P. Hurley, F. W. Sultan, W. Lee, F. J. Wetzel, A. A. Holland, L. H. Geyer.

Insley Mfg. Corporation
Block 9

Instruments, Inc.
West of Block S

International Harvester Company
Blocks 101, 104

Construction equipment and trucks including dozer tractor, welder tractor with twin welders, sideboom tractor, skid shovel, 385 hp turbo-charged power unit, rubber-tired sideboom and complete line of crawlers and engines. Rubber-tired commercial tractor display, including crane, tractor with mower, tractor with loader and back-hoe, tractor with trencher and backfill blade, and line of motor trucks.

Frank W. Jenks, Harry O. Bercher, Brooks McCormick, William C. Schumacher, Harold T. Reishus, Mark V. Keeler, Ralph M. Buzard, Earl Krogstad and Ed Rixman.

The International Nickel Co., Inc.
Texas Bldg., Booths 64, 65

IRECO — Industrial Division
Park Lane, Booth 12

I-T-E Circuit Breaker Co.
S & T Bldg., Booths 22, 23

Remote or automatic control of electric protective equipment, Kirk Key interlock systems, motor-operated mechanism for control of small air circuit breakers and a pneumatically-operated control system for metal-enclosed high voltage interrupter switches, pneumatic switch operator, low voltage power circuit breaker, and transformer core and coil assemblies and current-limiting circuit breaker.

The Iverson Supply Company
Kansas Bldg., Booths 88, 89, 90

J

Jamesbury Corporation
Oklahoma Bldg., Booth 41

Jensen Bros. Mfg. Co.
Kansas Bldg., Booth 21

Jensen Engineering Co.
North Area, Booths 45N, 46N

Crude oil, asphalt and product blending tank mixers, LPG and crude oil meter provers.

A. C. Jensen, L. R. Van Arsdale, Joel H. Carlson, Norton G. Rensch, Lee Nickerson, Hugh Brightwell.

Jet-Lube, Inc.
Oklahoma Bldg., Booth 134

Lubricating thread compounds, API high pressure thread compounds, Jet-Lube "applicator," rig washing compounds and specialties.

Jack C. Ballagh, Frank E. Bergeron, Joe Bergeron, Ray Morris, Hoyt E. Snelson.

Johnson-Fagg Engineering Co.
Park Lane, Booth 29

The S. M. Jones Co.
Oklahoma Bldg., Booths 15, 16

Jones & Laughlin Supply Co.
Block 1

Tubular good, wire rope, containers, oil field supplies.

Joy Mfg. Company
Block 104, Block 7

J. P. Machine & Tool Company
North Area, Booth 42N

Justrite Mfg. Co.
S & T Bldg., Booth 17

Johns-Manville
Oklahoma Bldg., Booths 44, 45, 46, 57

Thermal insulation, friction materials, brake linings and clutch facings, packings and gaskets for pumps, valves and flanges, pipeline protection materials, construction materials, filter aids for secondary recovery systems, a drying agent in air drilling, an absorbent for liquids in drilling compounds and transite pipe.

T. Jackson, W. S. Hough, C. A. Bailey, H. G. Palmer, W. Peters, W. J. Christman, J. S. Wiseman, T. N. Hall, R. M. Stafford, O. F. Johnson, J. A. Grimmer, N. M. Winter, C. Block, G. R. Smith, I. E. Cary, E. W. DeJon, O. F. Knopf, R. C. Powell, M. E. Duncan, G. H. MacGregor, F. K. Emken, R. D. Whitney, Jr., L. A. Mathews.

Johnston Testers, Inc.
Outside, Block 104

Full bore test and completion tool, anchoring device for selective zone testing and drill stem testing tools.

W. F. Bettis, John Flanagan, Phil H. Griffin, David G. Walker, L. B. Stansell, M. J. Armstrong, C. J. Beecham, I. L. Bolds, C. W. Brown, Jr., G. D. Davis, C. D. Gaither, Wayne Gorrell, B. F. Herridge, L. F. Jones, C. G. King, Leonard Long, R. E. Parker, H. M. Raymer, L. L. Rice, Fred Rippetoe, B. L. Smiley, C. H. Thomas.

The S. M. Jones Co.
Oklahoma Bldg., Booths 15, 16

Sucker rods and accessory items and a joint make-up display.

M. B. Jones, W. P. McBee, Coleman Curtiss Jr., Keith Moore, Ed Flavell, G. H. Ross, Nick Sinnott, W. R. Suggs, R. J. Pauly, Paul Wolfe, L. J. Pundt, C. W. Turner, W. H. Ritterbusch, Jr., M. B. Jones Jr., W. E Barfield, H F. Bratches, J. B. Frank.

K

Kendavis Industries, Inc., International
Northwest corner of Block 13

Ken W. Davis, Ken Davis, Jr., Thomas N. Shults, Victor LeMay, R. J. Bromell, John W. Tullis, P. Z. Hilliard, Jack P. Jones, H. E. Mallory.

Ken Corp.
Silver Lane, Between Booths 30 and 31

Oil well drilling fluids and down-hole packing materials.

Keith B. Bright, Earl V. Tavan, Jr., Neal B. Thompson.

Ben F. Kelley Co., Inc.
Silver Lane, Booths 36, 37

Kerotest Mfg. Co.
Oklahoma Bldg., Booths 89, 90, 121, 122

Cast steel valves and fittings, forged brass valves and fittings, demonstrations of hydrostatic seal test, flexure test, valve operation.

W. G. Young, W. Swaney, E. Wrenshall, W. Pell, S. Dickinson, O. Menzi T. H. Everingham, O. Alexander, W. Cosgrove, K. Harger, D. Cox, H. Herndon, J. D. Isaacks.

Kerr-McGee Oil Industries, Inc.
Oklahoma Bldg., Booths 63, 64

M. M. Kinley Co.
Silver Lane, Booth 38

Klemp Metal Grating Corp.
North Area, Booths 84N, 85N

The Koehring Company
West Area, Block 115

Kohler Company
Kansas Bldg., Booths 39, 40

Koppers Co., Inc.
Texas Bldg., Booths 73, 74, 75

Safety spinning and breakout catheads, safety air operated rotary drilling drill pipe, casing and tubing slips, safety type "K" fulgrip tubing and workover tongs.

Ben F. Kelley, B. F. Kelley, Jr., Ray Sloan, Colonel Parsons, E. C. (Ed) Prasuhn, C. M. (Pete) Peterson, M. O. (Mack) Webb, O. L. (Lee) Franks, G. Barney Blair, Ed Cowley, Marc Lamkin, Ray Cash, Carl Moulden, Dick Moyer, Marshall E. Niedecker, LeRoy Ducommun.

Kobe, Inc.
Oklahoma Bldg., Booths 217, 218, 233, 234

Hydraulic pumping unit, automated pumping, special pumping systems for large volumes, heavy oil, dual zones.

C. J. Coberly, W. F. Slater, R. Elner, R. G. Ralph, C. P. Brown, K. D. Snedeker, J. M. Ward, W. P. Wallace, C. E. Edwards, H. W. Wilson, J. T. Lewis, P. M. Wilson.

L

Ladis Co.; Ladish Co., Texas Div.; Ladish Pacific Div.; Ladish Co. of Canada, Ltd.; Ladish Co., Hasco Div.
Kansas Bldg., Booths 7, 8, 9

Welding fittings, flanges, screwed and socket fittings and unions, corrosion resistant valves, multiple outlet fittings, 3-R elbows, anchor flanges, hot tap reinforcing tees and other special fittings, tri-clamp fittings.

S. Antolovich, J. A. Blaney, R. Blom, R. M. Bode, D. S. Bradbury, V. F. Braun, W. F. Bockwell, J. M. Browning, W. B. Dickey, H. C. Ende, Jr., C. A. Furgason, C. C. Gladson, D. K. Greenwald, J. F. Hacker, J. G. Henderson, S. J. Hintz, G. Hudson, M. S. Kachigan, F. K. Krell, G. H. Loeffler, G. G. Maclay, G. E. Mahoney, R. T. Meek, R. A. Payne, H. L. Pehrson, C. M. Steinbrecher, T. L. Swansen, W. R. Wollering.

Landis Machine Co.
California Bldg., Booths 17, 18

Receding head machine, thread cutting die heads, thread rolling die heads, collapsible taps and thread rolling attachments.

D. Roy Stoner, Jr., R. G. Mumma, J. R. Funk.

Larkin & Company, Inc.
California Bldg., Booth 58

Leavitt Machine Company
Park Lane, Booth 26

LeBus International Engineers, Inc.
Texas Bldg., Booth 70, 71

Counterbalance wire line spooling systems, anchor washpipe spear, telescope drill joints, full opening knuckle joints, unlatching joints.

F. L. LeBus, Sr., F. L. LeBus, Jr., Earl L. Calk, W. B. Charleville, J. H. Chrietzberg, Lonnie D. Thompson.

Lee Construction Corp.
Kansas Bldg., Booths 26, 27

Le Roi
Division Westinghouse Air Brake Co.
Block R

R. G. LeTourneau, Inc.
Kansas Bldg., Booths 93, 94

The Lincoln Electric Co.
Oklahoma Bldg., Booth 202

Tandem arc submerged arc welding demonstration with two automatic welders, full line of arc welders, electrodes and supplies.

J. F. Lincoln, A. F. Davis, J. S. Roscoe, A. W. Sawyer, C. L. Lawton, R L. Looney, R. P. Schaub, D. G. Ellis, B. E. Walcott, E. B. Reeves

Line Scale Company
Oklahoma Bldg., Booth 205

Link-Belt Co.
Texas, Bldg., Booths 61 - 63

Film "Roller Chain's Dynamic Decade," spherical roller bearings, P. I. V. (positive, infinitely variable) speed drive and a parallel shaft speed reducer.

Lister-Blackstone, Inc.
North Area, Booth 15N

Air cooled diesel engine and diesel air cooled generating set.

G. C. Mouser, M. C. Berry.

Lone Star Steel Co.
Texas Bldg., Booth 69

Steel casing, linepipe and tubing, and cast iron pressure pipe.

E. B. Germany, Walter T. Moreland, L. D. "Red" Webster, B. C. Robertson, Don Weeks, Ray Sexton, Clyde Eddy, J. D. Dillard.

Loveless Mfg. Co.
Block 107

Lufkin Foundry and Machine Co.
Mid-Continent Drive, between Texas Dr. and Pennsylvania Ave.

Beam-type pumping equipment, gas engines, marine and commercial gears, and largest pumping unit.

W. W. Trout, L. A. Little, E. P. Trout, C. D. Richards.

The Lufkin Rule Co.
Texas Bldg., Booths 121, 122

New dial indicators, vernier height gages, precision hand tools, measuring tapes and rules.

Donald F. Oltz, Jack Walsh, Frank Jordan, Robert Young, R. T. Lone, Edward Szabo, E. J. Schroder.

The Lunkenheimer Co.
Oklahoma Bldg. Booths 67, 68

Steel, iron, bronze and corrosion-resistant valves.

Paul M. Arnall, H. E. Lunken, E. P. Lunken, M. W. Pauly, E. F. Riopelle, Jack Douglas, Wm. Boles, Jack Green, Ed Bullard.

Lycoming Division, AVCO Mfg. Corp.
Park Lane, Booths 15, 16

T53 Industrial and gas turbine engines.

Dr. Fritz Haber, Leroy A. Howard, Kenneth A. Austin, Donald L. Kidd, Alec Voight.

Lynes, Inc.
North Area, Corner of Le Duc Dr. and Barco Blvd., Booth 31N

Inflatable open-hole production-injection packer.

George Canfield, Ernest Stokey, George Conover, Erv Hoffman, Bob Leary, Vernon Stewart, Otis Petty, Malcolm Coone, Paul Stovey, Bill Harmon.

Mc

McCord Corporation
Oklahoma Bldg., Booths 72, 73

McCullough Tool Company
Block 104

McEvoy Co., Newman, Hender & Co., Ltd.
Kansas Bldg., 91 - 92, 36 Parklane

Wellhead equipment, Christmas trees, valves, and gas lift valves, pipeline valve.

C. F. Johnson, J. C. Rebman, A. F. Rhodes, J. C. Sikes, John Webb, Jack Roff, Billy Oden, M. H. Dean, Jim Foster, John Beson, Ray Newman.

McFarland Engineering & Pump Co.
Texas Drive, Booth 5

Automatic pipeline samplers, LACT unit samplers, chemical proportioning pumps, hydrostatic testing pumps.

R. E. Fuller, A. F. McFarland, A. E. McFarland, P. B. Hamilton.

McKissick Products Corporation
Oklahoma Bldg., Booths 245, 246

C. W. McNeil, Inc.
Texas Bldg., Booths 83, 84

Aetna Ball & Roller Bearing Co.: anti-friction bearings and package units; Rollway Bearing Co.: straight cylindrical roller bearings, both radial and thrust; Shafer Bearing Div., Chain Belt Co.: pillow blocks, flange units and cartridge takeup units and aircraft bearings; and Poole Foundry and Machine Co.: flexible couplings for direct connected machinery.

C. W. McNeil, Mrs. J. Cherry, T. L. Gray, and R. L. Heisler (C. W. McNeil, Inc.); J. J. Rozner, H. F. Wendt, J. E. Dillon, M. D. Berg, and T. Swartwout (Aetna Ball & Roller Bearing Co.); A. Alven, H. Kaye and G. C. Hall (Rollway Bearing Co.); Horace Tennes, Robert Hunter, Art Williams, P. Grumieux and Bob Lange (Shafer Bearing Div., Chain Belt. Co.); and L. M. Ricketts (Poole Foundry and Machine Co.).

M

Mack Trucks, Inc.
North Area, Block 202

Macwhyte Wire Rope Co.
Oklahoma Bldg., Booths 130, 131

Special wire ropes and slings, internally lubricated rotary drilling line, stainless steel rope, Monel metal rope, plastic and nylon coated

rope, cable-laid and braided wire rope slings.
Forest J. Nelson, Goodwin Johnston, Francis D. Holden, George C. Wilder, Don Wood, Paul Burks, Bob Konitz, Matt Mulich.

Magnaflux Corporation
Silver Lane, Booths 10, 11

Magneto Ignition Company
Kansas Bldg., Booths 130, 131

Maloney Crawford Tank & Mfg. Co.
Texas Bldg., Booths 116, 117

F. H. Maloney Company
Texas Bldg., Booth 14

Manning, Maxwell & Moore, Inc. (Stratford, Conn.)
Oklahoma Bldg., Booths 229, 230

Manning, Maxwell & Moore, Inc., Shaw Box Division (Muskegon, Michigan)
West Area, East of Block 115

Charles E. Manning Co.
North Area, Booth 9N

Grooved-type couplings and fittings, and "swing-bolt" grooved-type coupling.
Charles E. Manning, Jr., Paul J. Welsh.

Manzel, Unit of Houdaille Industries, Inc.
Oklahoma Bldg., Booth 50

Force feed lubricators, chemical feeders, slurry pumps.
Granger Thurstone, Bob Meyers, Sydney Leese, Don Patterson, Joe Marz, Swede Nelson, Ed Bromiley, Carl Gast, Lynt Scharff.

Marathon Electric Mfg. Corp., Large Apparatus Div.
Oklahoma Bldg., Booths 206, 207

Marine Products Co.
North End, 61N - 62N - 63N

Portable, engine driven rotary pump, portable engine driven self priming centrifugal pumps, straight centrifugal pumps.
R. F. Fernstrum, F. M. Kaufman, J. G. Carr.

Marsh & Marine Mfg. Co., Inc.
East Area, Block 1E

Portable camps, portable buildings, portable living quarters, portable offices, portable mess halls, portable recreation building, seismograph equipment, pressure geophones, protective coatings, reflective coatings.
Don B. Karlskind, Greg F. Walsh.

Wm. H. Mason Company
North Area, Booths 72N, 73N

Massey-Ferguson Industrial Division
S & T Building, Booth 62

C. A. Mathey Machine Works, Inc.
Southeast corner Drumright Ave.
and Cushing Lane

Measuring line reels, measure meters, detachable spool reel, Gulf Coast special reel, skid mounted, with cover (diesel and hydraulic powered), pipe cutting and beveling machines, coupon cutter, automatic release (pipe handling) tongs, flange line-up pins, gas testing unit.
O. F. Dickenson, W. W. Cabell, L. V. Orton.

Mayhew Machine & Supply Company
West Area, Block 118

Metallizing Engineering Co., Inc.
North Area, Booths 86N, 87N

Metallurgical Products Dept., General Electric
Carboloy cemented carbide.

Gerald Nalon, Ed Boersig, Raymond F. Parker, Leonard Budzen, George Hartley, William Reich.

Metalock Casting Repair Company
Silver Lane, Booth 13

Mid-Continent Supply Co.
Blocks 3, 12, 13, 14

A complete line of oil field products and machinery.
D. H. Thornbury, J. H. Kenyon, H. D. Powell, T. M. Cone, R. M. Flippo, R. E. Elmore, W. B. Nance, R. L. Harris, A. A. Pike, D. S. Smith, W. W. Arnold, R. L. McAnally, A. Z. Day, C. W. Crabtree, J. A. Daugherty, R. S. Weilman, W. R. Shuffield, C. R. Lowry, W. W. Schmid, T. P. Tarwater, G. L. Huestis, J. H. Conine, J. O. Ramsey, J. W. Eastham, R. L. Moyer, G. A. Wead, C. M. Fleeman, D. Rust, L. T. Ratliff, R. C. Holden, A. V. Johnson, C. H. Hickman, A. L. Murry.

Midwestern Engine & Equipment Co. Inc.
Block 107

Hydra-lift, aerial platform, grader, power shovel, centrifugal pumps, trencher points and adapters, hydra-hammer.
A. H. Bost, R. W. Karlovich, Wm. F. Winkler, Jack R. Martin.

Midwestern Mfg. Company
Block 107

Sideboom wheel-type tractors, backfiller, crawler tractors.
A. H. Bost, R. W. Karlovich, Ray O. Branam.

Midwestern Pipe Line Products Co.
Block 107

Pipe wrap and coatings, pipe coating and beveling machines, casing seals and insulators, pigs, line-up clamps, pipe tongs, pipe slings, anodes and welding equipment.
A. H. Bost, R. W. Karlovich, John R. Wilson.

Mine Safety Appliance Co.
Oklahoma Bldg., Booths 48, 49

Complete line of safety equipment for the petroleum industry, combustable gas analyzers, and infra red analyzers.
N. W. Hartz, F. A. King, J. P. Sherwin, E. J. Finear, J. T. Willams, W. H. Gates, W. J. Young.

Minneapolis-Honeywell Regulator Co.
S & T Bldg., Booths 41, 42, 43

Telemetering system miniature electric instrumentation, data handling system, control valves, thermocouples, pressure controls, laboratory potentiometer, bellows flow meter.
A. F. Day, J. T. Pitts, J. Smith, P. Sharadin, C. F. Woods, J. E. Vermillion, T. R Coleman, B. J. O'Toole, I. W. Vail, D. D. Baker, W. E. Hiller, E. A. Tanner, C. D. Adams, C. D. Walker, W. G. Hardy, A. F. Geraghty, G. Cullen, W. R. Banta, J. M. Kennedy, F. J. Long, W. D. Betts, R. P. Walker, J. Miles, J. Stickley, R. E. Harris, C. L. Dozois, C. E. Higbee, J. Teed, C. L. Peterson, O. B. Wilson, J. A. Robinson, R. Mallory, H. Ruch.

Minneapolis-Moline Company
S & T Bldg.

Minnesota Mining & Mfg. Company
Kansas Bldg., Booths 41, 42, 43

Mission Mfg. Co.
Texas Bldg., Booths 91 - 93 and 118 - 120

Fluid end parts for reciprocating pumps, valves, rotary slips, swabs, bottom-hole pneumatic impact tool for hard rock drilling, centrifugal pumps.
Richard E. White, John S. Stewart, T. R. Fullinwider, C. R. Summers, W. O. Calvert, John H. Bannister, John H. Brown, A. E. Higginbotham, M. V. Sparks.

Lee C. Moore Corp.
Oklahoma Bldg., Booths 65, 66

Drilling structures — masts, derricks, and etc. Five miniature models of various types and sizes of drilling derricks and masts. Three full sized portable drilling masts and one full sized derrick as part of four different supply companies, exhibits.
H. J. Woolslayer, N. F. Rohrkaste, G. A. Holloway, G. I. Lynch, Newton Chapin, Jr., J. R. Roberts, A. B. Dunham, J. E. Harrell, C. L. Howes, J. H. Ross, H. L Clawson, H. G. Ellig, W. I. Salnikov, W. H. Parker.

Moran Furnace & Sheet Metal Co.
East of the Kansas Bldg.

Meter houses, fire houses, heaters, positive draft controls, draft equalizing stack heads.
W. O. Moran, D. W. Combs, L. D. Vaughan, C. F. Dougherty, E. L. Houston, R. L. Keeling, C. J. Tucker, Virgil Spiker, Sam Orr.

Morrow Engineering Specialty Company
Texas Bldg., Booth 8

Morse Chain Co.
Silver Lane, Booths 14, 15, 16

Basic chain drives, chain, sprockets, "timing" belt sprockets, couplings, driveshafts, clutches, torque limiters and speed reducers.
R. O. Bass, J. V. Moynes, R. J. Koch, R. M. Katzenberger, F. L. Wood, C. B. Lane, T. K. Stanley.

Motorola, Inc., Communications & Electronics Div.
S & T Building, Booth 81

Mountain Iron and Supply Co.
Oklahoma Bldg., Booths 96, 97, 98

Rest lounge, telephone booth, foot vibrators.
S. O. Beren, Al Bouse, Bob Miller, Ralph Hamilton, Carl Axelson, Russ Rishel, Allen Staub, Gene Turner, Bill Webster, Bill Frevert, Lee DeWeese, Clarence Wiley, Lawrence Jeck, V. V. Davidson, Walter Ruder, R. V. Reissig, J. D. McClure, R. Q. Lane, Wilbur Cross.

Mud Control Laboratories, Inc.
Kansas Bldg., Booth 123, 124

A complete mobil mud testing laboratory.
R. J. Carlson, Foy Smith, R. H. Saunders, R. D. Blaicher, Lane Ligon, Lindsey Jackman, W. C. Summy, A. G. Schuessler, C. B. Swain.

Multi-Color Process Company
Park Lane, Booth 20

Murphy Diesel Co.
West of Block Q, Section 9N Ramp

Engines, power units, dual-fuel engines, marine engines, generator sets, sectional cutaways of injector, oil pump, governor, water pump, piston and connecting rod.
John Vogler, James Vogl, Lee Delaney, Paul Schnetzky, Frank Hurley, Paul James, North Jones.

Frank W. Murphy Mfr., Inc.
California Bldg., Booths 14, 15

Working miniature models of automatic waterflood system. Engine oil pressure, oil level, water temperature, oil temperature and overspeed safety shutdown switches. Modular instrument panels for gas compressor and pipeline pump stations.
Frank W. Murphy, G. B. Schapaugh, Jim Barnes, Art Murphy, J. Sam Francisco, Johnnie Weiche, Don Altman, Perry Ward, Jim Wheaton.

N

The National Supply Co.
Drake Drive, Block 1

Mechanical electric super-deep drilling rig, including diesel engines, generators, motors, engine compound, hydraulic couplings, mud pumps, Micromatic drilling control, Multimatic rotary, swivel and 500-ton hook-block; medium-depth rotary rig for both conventional and trailer mounting, with two engine sets, troque converter and slush pump; the "Helicopter rig" with slush pump and four engines; fluid end parts, torque converter, specialty pipe products; pumping units operated in unison and dual pumping installation; well heads; triplex plunger pump; sucker rod products and plunger lift display.
J. S. Blair, L. P. Baldwin, D. F. Bannan, C. W. Bartholomew, R. M. Borden, L. A. Carlson, Jr.,

R. W. Colebrook, R. N. Cordrey, A. B. Geddes, A. L. Harrington, C. P. Jenkins, D. D. Jones, T. M. Lawson, G. R. Bond, E. G. Bartley, E. G. Blaisdell, R. H. Caldwell, D. J. Cornelson, L. A. Harris, R. B. Hill, W. M. Powell, D. G. Knox, R. J. Kucel, G. L. Lindner, J. M. Meadows, S. J. Milam, J. D. Mitcham, Frank Pearson, F. J. Pendred, A. S. Pitchford, W. P. Van Order, J. R. Van Wie, E. M. Winans, M. E. Young, Bill Mitchell, R. G. Morrison, J. M. Norman, A. J. Otte, W. V. Schneider, J. S. Spencer, T. L. Tyson. G. A. Baber, Jr., T. L. Blose, W. F. Schmeling, C. Swartstager, W. R. Ryburn, J. A. Kennedy, C. M. Struffolino.

National Tank Company
Block S

Nelson Electric Mfg. Company
Kansas Bldg., Booths 65, 66

W. C. Norris, Mfgrs. Div. Dover Corp.
Block 5

New wafer type butterfly valve, sucker rods and well head equipment.

G. W. Davidson, D. P. Hagaman, J. A. Getty, Jack C. Schaff, Earl Carpenter, Clyde C. Sights, W. J. Whitaker, C. L. Snelling, Frank Nostrand, Hamp Brooke, Dan Coates, Paul Colvard, Gordon Shay, Bob Roberts. Don Smith, W. C. Tolleson, Leroy Mitchell, Kenneth Cook, Don Burvin, A. L. Ethriedge, Cecil T. Fair, J. E. Giles, Kenneth Hance, Homer Hill, Dwight Maney, M. E. McKelvey, M. L. Parker, Bill Peterson, R. L. Preston, Bill C. Robinson, J. G. Russell, Don W. Stewart, and George White.

Wm. W. Nugent and Co., Inc.
Oklahoma Bldg., Booths 171, 172

Lubricating oil and fuel oil filters, working model of oiling system for bearing lubrication, sight feed valves, sight flow indicators, multiple oilers and other lubricating devices.

F. L. Townsend, C. D. Nugent, J. Vocelka, W. W. Nugent, R. E. Pearson, T. F. Hudgins, Dallas S. Deem.

Nutro Products Corporation
Park Lane, Booth 17

O

Oakite Products, Inc.
Texas Bldg., Booths 22, 23

Compounds for cleaning and descaling towers and heat exchangers, methods of steam and hot tank cleaning, paint stripping, service laboratory.

W. A. Baltzell, T. C. Zimmerman, F. C. Weber, R. E. Tschupp, J. D. Hudson, L. A. Blankenship, B. P. Fortin, W. A. Russell, H. T. Hancock, J. R. Ham, R. W. Krajicek, W. A. Woolman, J. R. Whyte.

Walter O'Bannon Co.
Oklahoma Bldg., Booths 85, 86

Subsurface pumps, well servicing tools.

The Ohio Injector Company
Oklahoma Bldg., Booths 219, 220, 231, 232

Oil Center Tool Co.
Texas Bldg., Booths 104, 105

Wellhead equipment.

W. A. Wolff, Jim Witovec, Fritz Richard, C. Ross Spencer, C. T. Jones, M. E. (Mike) Hunter, A. C. (Bus) West, L. J. Piwetz Russell Blair, J. R. Yancey, Dr. J. M. Lebeaux, H. O. Quebe, Jerry Boyd, Peter DeMarsh, Wm. Todd, Stan Daniels, Roy Boeker, John Greenwood, Carlos Ballard, John Zawacki, George V. Berg, Ray White, B. G. Barefield, Frank Murray, J. G. Simmons, Henry Simonton, LeRoy Jensen, Walter Burke, Ray Cunningham, E. H. Fletcher, Myles Esterak, Louis Loudermilk, Jerry Allen, Harry McDow, Bill Jones, R. H. (Bob) Wright, Frank Bates, B. C. Hensley, Chas. Ellison, A. M. Taylor, Roy Hisel, Jesse Young, J. J. Humphries, D. L. Tanner, Willard Chiasson, Chas. Linscomb, Chas. Dunnell, Jim Tharp, Ernest Parra, Gil Lastrapes, Leon Black, H. C. Stewart, J. B. Hall, Wm. (Irish) Delaney, Cliff Brake, Jack L. Simms, John Harvey.

Oil Metering and Processing Equipment Corp.
Hall of Science Bldg., East Door, Block 120

Metering separators, well testers, volumeters, metering free water knockouts, metering treaters, automatic lease metering and sampling unit, other related metering and testing equipment.

H. Vernon Smith, George A. Repal, J. D. Kimmel, O. G. Houser, Jack Cable, Al Tweelings, Ralph Nelson, John Weideman, George Boy, James O. Gravitt, Norman E. Yett, Ed Noble, Leon Chesser.

Oil States Rubber Co.
Oklahoma Bldg., Booth 224

Tubing and swabs, sucker rod guides, tubing guides, oil saver rubbers, pipe wipers, custom molded oil field rubber goods.

H. E. Bowerman, G. C. Waldrop, Tom C. Waldrop. John Ekey, Merle Richardson, Glen Harris, Jack Records, L. E. Brookover, Gene Norman, T. E. Keefer, Jim Hollingsworth, C. B. Alexander, Jerry West, Fred Britton, Jim Wortham.

Oil Tool Manufacturing Co., Inc.
Oklahoma Bldg., Booth 154

Rock bits (exploration drilling), subs and adaptors.

C. F. Williams, R. E. Suter, G. B. Morton, Ray Oswald, George Chandler, J. T. Williams, Leo Hurtubise, Van White, J. N. Huskey, Dr. Dean Gradjansky, Roger Williams.

Oil Well Supply, Div. U. S. Steel Corp.
Plot No. 1, corner Drake Dr. and 21st St.

Mast (working scale model), draw works with 3-engine drive and automatic feed control, rotary, Swivel, 200-B-150 and 250-W-250 block hooks, power slush pump, pumping units, compressor units, plunger pumps for waterflood service, subsurface pumps, sucker rods and couplings, pumping unit engines, duplex pump service, electric generator units and cathodic protection applications, centrifugal process pumps.

D. W. Onan & Sons, Inc.
Block T

Orbit Valve Co.
Texas Bldg., Booths 33, 34, 35

Valves for Christmas trees, general production use and drilling service, valves, ASA class for liquids and gases and valves remotely actuated.

L. E. Wallace, C. J. Folger, Ralph H. Soape, H. C. Sawyer, James P. Bowling, Jack H. Hancock, Jack J. Gavin, J. Dock Mumford.

Otis Engineering Corporation
Texas Bldg., Booth 113

O-T-M Corporation
S & T Bldg., Booths 29, 30

Owens-Corning Fiberglas Corp.
Kansas Bldg., Booths 97, 98, 119 - 122

P

Pacific Mercury
S & T Bldg., Booth 21

Construction equipment, electric plants, flasher warning lights, concrete vibrator, and accessory construction equipment.

Eugene John Freeman, Lorin McCarthy, John Graham, Sanford LeBow.

Pacific Pumps, Inc.
Dresser Bldg.

Oil well plunger pumps, centrifugal pumps, steam turbopumps.

A. R. Weis, E. J. Weis, E. A. Loth, D. B. Harney, M. F. Ecker, H. G. Hubbard, A. F. Canada, Jr., J. W. McCormick, W. H. Wagner, W. J. Bahler, G. F. Graham, D. E. Harder.

Henry H. Paris Distributor Inc.
California Bldg., Booths 20, 21, 22

Parker Seal Co., Division of Parker-Hannifin Corp.
North Area, Booth 16N

Pipe flange connection seals and synthetic rubber O-rings.

S. E. Voran, Rance MacFarland, Milt E. Fassnacht, Don T. McDowell, John G. Oechsner.

The Parkersburg Rig & Reel Co.
Corner of Oklahoma Dr. and Mid-Continent Dr.

Hydrocarbon recovery and dehydration units, low temperature separator, short-cycle adsorption units, glycol gas dehydration units, oil and gas separators, automatic custody transfer unit, steel buildings air-balanced pumping unit with automatic balancing device, conventional chain drive and gear drive pumping units, hydromatic brakes for drawworks and new type well head pumping device.

B. P. McDonough, J. W. Robbins, J. M. Baldridge, W. J. Slaughter, C. M. Ferguson, D. O. Larkin, C. W. Barnhart, W. H. Land, C. D. Haehl, G. B. Camden C. M. Rowley A. G. Evans-Lombe.

The Partlow Corp.
Silver Lane, Booth 35

Thermal sensing elements for $LACT_7$ combustion safeguards for shutdown of fuel lines of oil field heater-treaters; temperature controls, including indicating, recording, electric and pneumatic, plus a line of non-indicating, self-contained, thermally-actuated gas valves, both throttling and on-off types.

Howard W. Partlow, Wayne A. McGrew, F. Abbott Chapman, C. W. Pflieger, W. C. Roberts, C. A. Drum, Robert C. Lamb.

Payne Mfg. Co., Inc.
Kansas Bldg., Booths 132, 133

Blowout preventer operating units, non-separator type accumulators, and test pumps.

V. H. Payne, W. E. Webster, B. H. Dykes, W. C. Filler, R. A. Bridges.

Peerless Mfg. Co.
Oklahoma Bldg., Booths 215, 216

Separation equipment (liquid and dust from gas), Mist extractors, flex-ring closures and "O" ring closures.

Mrs. Laura B. Sillers, Donald A. Sillers, Jr., John C. Thompson, Charles B. Valliant, William M. Neale, Charles L. Stevens, E. Murray Smith, Wallace E. Horton.

Peerless Pump Division, F.M.C.
Oklahoma Bldg., Booths 11, 12

Deep well pumps for secondary recovery and horizontal centrifugal pumps.

R. T. Axworthy, T. E. Schroeder, W. J. Blair, W. E. Griffin, J. F. Dyer, R. C. Hatch, P. M. Dixon, G. C. Carnahan, C. S. Hoeppner, K. E. Condray, J. E. Morris, M. H. Richter, S. M. Riordan.

Pelton Division of Baldwin-Lima-Hamilton Corp.
Park Lane, Booth 34

Penberthy Manufacturing Company
North Area, Booths 13N, 14N

Perfect Circle Corp., Cosasco Div.
Oklahoma Bldg., Booths 26, 27

Perfex Corp.
Silver Lane, Booths 42, 43

Jacket water coolers, heat exchangers, radiators and coils.

Perforating Guns Atlas Corp.
North Area, Booth 1N

Electrical logging nuclear logging, spectral logging services, bullet and jet guns, perforating techniques, strata test equipment, continuous dipmeter service, lateral log and micro lateral log, induction electrical logging.

P. Charrin, W. L. Young, Ross B. Smith, Rob-

ert D. Tibbs, Philip Stoore, Jr., J. C. Neville, Zeke Strange, E. D. Swartwood, B. D. McInturff, Roy M. Rhodes.

Perrault Equipment Co., Inc.
Block 102

Coating and wrapping equipment, cleaning and priming equipment, melting kettles, pipeline wrapping materials, internal line-up clamps, welding machines.

W. O. Dixon, V. V. Malcolm, Jim Romeis, Roy Childress, H. M. Jones, Walter Bryant.

Perry Equipment Company
California Bldg., Outside East End

Oil, gas and water filtering equipment, liquid phase separators and intake air cleaners.

The Petroleum Engineer Publishing Company
Corner Mid-Continent at Texas Drive

Specialized petroleum industry publications.

Joe B. Woods, Abbott Sparks, E. V. Perkins, J. E. Kastrop, John McDonald, Clyde Dillehay, Robert T. Mahoney, Richard P. McKey, Art Gilliam, Jess Adkins, Ed Sealey, Paul Mansfield, Jack W. Williamson, Joe C. Webb, Frank H. Love, Ernestine Adams, Lowell A. Murphy, C. R. Graham, Royal Courtney, Charles McKean, Sherwood Entwistle, Dean Hale.

Petrolite Corporation
Block U

Philadelphia Gear Works, Inc.
S & T Bldg., Booths 85, 86, 20

Phillips Petroleum Company
Texas Bldg., Booths 106, 107

Display theme is diversification of Phillips' activities: refined petroleum products, rubber chemicals, plastics, hydrocarbons, process licensing, atomic energy and uranium milling and mining.

Pioneer Centrifuging Co.
North Area, Booths 19, 20, 21

Drilling mud centrifuges, desanders, mud pump valves and seats.

C. E. Church, C. P. Gillespie, Jr., E. O. Ernst, D. K. Gillespie, Al Beothe.

Pipecote Service Corporation
East Area, Block 4E

The Pipeline Engineer
Corner Mid-Continent at Texas Drive

Joe B. Woods, Abbott Sparks, E. V. Perkins, J. E. Kastrop, John McDonald, Clyde Dillehay, Robert T. Mahoney, Richard P. McKey, Art Gillam, Jess Adkins, Ed Sealey, Paul Mansfield, Frank H. Love, Royal Courtney, Charles McKean, Sherwood Entwistle.

The Pipe Line Development Co.
North Area, Booths 57N, 58N

Pipeline safety welding couplings, clamps, flanges, pipeline weld repair equipment.

Piper Aircraft Corp.
Block 117

General aviation aircraft.

W. T. Piper, Sr., J. W. Miller, W. C. Smith, C. E. Bockstahler, A. P. Whiteway.

Pittsburgh Steel Co.
Texas Bldg., Booths 4, 5, 6

Oil country tubular products and other seamless tubular products, flat rolled products, wire and wire products, specialty strip products.

Allison R. Maxwell, Jr., Donald C. Duvall, Marvin J. Bair, John C. Cercone, Joseph E. Simonin, E. R. Smith, Bruno R. Mueller, R. W. Mullin, A. S. Vandervoort, Jr., T. R. Miller, W. H. Rowe, Jr., John Wais.

Plan Hold Corp.
S & T Bldg., Booth 66

Vertical and roll filing equipment, systems and supplies, easelbinders for carrying and reviewing maps, charts, plans, etc.

O. K. Schneider, Rose Schneider.

H. K. Porter Company, Inc.
Oklahoma Bldg., Booths 22 - 25

Potter Aeronautical
North Area, Booths 81N, 82N

Power Plus Corp.
Park Lane, Booths 31 - 33

Oil level regulators, exhaust condensers, low delivery pressure regulator meters.

D. M. Nelson, Al Dunn, H. G. Lawrence, George Boy, Billie Goan, L. D. Harbour, Mose Quinn, L. S. Robb, O. G. Houser.

Practical Engineering Co.
Kansas Bldg., Booth 38

Precision Manufacturing Co.
North Area, North of Block 10

Precision Products, Inc.
Booths 42 and 43

Mechanical timing devices, precision instruments, precision parts, metal stampings, electronic hardness tester.

G. E. Nicholson, L. E. Bates, Jr., C. R. Ridley, I. G. Johnson.

Preformed Metal Products Co. Inc. (Premetco)
Texas Drive, Booth 7

Aluminum jacketing and elbows for covering insulated lines, chemical resistent coated aluminum covering materials, stack rings for attaching aluminum to hot stacks, and roofing alloy for covering insulated tanks and towers.

Premetco (Glen Mason, Cunningham & Assoc.)
Texas Drive, Booth 7

H. C. Price Co.
Oklahoma Bldg., Booths 204, 205, 247, 248

Pipe coatings and enamels, internal and external coatings, river weights, sample bell and spigot, double bell end, cable pipe with cable, steam pipe sample and 30 in. sample of automatic welding.

H. C. Price, Sr., Harold Price, Jr., Joe D. Price, R. P. White, E. L. Gallery, R. K. Shivel, R. E. Burgess.

Process Equipment Company
Kansas Bldg., Booth 77

Procon, Incorporated
S & T Bldg., Booth 62

Producers Chemical Co. and Circulation, Inc.
Park Lane, Booths 27, 28

Working model of the Holt bottom-hole ball magazine. Materials used in acidizing, fracturing, cementing, and lost circulation.

W. A. Hill, James D. Rohde, Fred Clark, Jerry Guinn, Bob Cory, E. H. Daniels, E. F. Emmons, Ted Lewis, Bob Hines, Jim Willis, J. W. Snider, Jerry Ioti, Ed Brame, J. C. Childers, B. K. Germany, Earl Hague, Jim Hysell, Clarence Moore, E. D. McDonald, Ray Phillips, Phill Reese, Jim Scott.

Progressive Brass Mfg. Co.
Texas Bldg., Booth 11

Bronze bearings all types non-ferrous castings and finished parts.

Dan A. Mitchell, Wm. Shoefstall, Dale E. Wagner, C. O. Beckett.

Public Service Co. of Oklahoma
Southwest corner of Cafeteria

Purolator Products Company
Oklahoma Bldg., Booths 17, 18

The Pyle-National Co.
S & T Bldg., Booth 9

Conduit fittings, circuit controls, connectors, plugs and receptacles, lighting equipment, steam turbines.

James Dodge, John Crocker, Ray Thomas.

Pyrene C-O-Two Div. of The Fyr-Fyter Co.
Oklahoma Bldg., Booth 38

Q

Quincy Compressor Co.
North Area, Booth 38

Air compressors from 1 to 92 cfm.

Loren Gillhouse, George Pfeifer, M. J. Weber, R. L. Dobey, Claude Lowe, Harold Stone, Roy Nesbitt, J. M. Semke.

R

The Ramo-Wooldridge Corporation
Kansas Bldg., Booths 95, 96

Ramsey Winch Mfg. Company
North of California Bldg.

Rector Well Equipment Co.
Oklahoma Bldg., Booths 19, 20, 21

Well head equipment, cementing equipment, joint sealing compound.

L. L. Rector, R. R. Rector, J. L. Pinkard, John L. Curry, W. P. Knight, M. C. Davis, C. L. Cron, Chas. W. Zartman, G. H. Stewart, A. J. LaBate, M. O. Andrews, George Garratt, Bill Freeman, J. D. Sloman, R. B. Yanaway, Sam Beavers, Jr., Grady L. Cooper, Ray D. Goodnight, Paul G. Honeycutt, T. C. McDonald, Phil Jackson, Coy Brown, H. M. Pilgrim, W. R. Singletary, C. L. Splawn, Jim Thomas, W. R. Tipsword, Lou D. Cochran.

Reda Pump Company
Kansas Bldg., Booths 50, 51, 54, 55

Reed Roller Bit Co.
Reed Building

Rock bits, tool joints, drill collars, coring equipment, portable pneumatic tools.

J. F. Maher, H. B. Book, J. A. Grundy, W. B. Noble, J. K. Knight, R. G. Brandes, C. J. Fontaine, R. C. Huffines, R. C. Gann, S. P. Hazlip, W. H. Armstrong, H. B. Wilson, R. F. Roberts, B. A. Wendt, M. J. Cueto, John Orton, Vladimir Edelberg, A. A. Ezzell, R. V. Ellis, M. F. Wright, R. E. Conatser, O. J. Bishop, A. G. Metcalf, L. F. Williams, Bob Frederick, A. M. Christman, H. W. Kirby, B. W. Click, H. E. Giles, O. T. Shaw, C. F. Dinger, G. Krausert, G. H. Kimbrell, T. M. Sanders, T. R. Williams, T. R. Childs, Jr., W. H. Greenstreet, C. L. Wiley, E. E. Robertson, C. B. Caldwell, C. M. Barnes, J. H. Robertson, D. H. Reat, F. C. Stopple, J. J. Young.

The Refinery Engineering Co.
S & T Bldg., Booths 31, 32, 87

Scale model of one sulfuric acid alkylation unit.

T. M. Lumly, E. W. Upton, Paul Smith, H. V. Flemming, Jr., D. F. Ferguson, J. Ray Stough, John Rodolf, C. D. McDowell, J. C. Bradford, Joan Heath.

The Refinery Supply Co.
S & T Bldg., Booth 8

The Refining Engineer
Corner Mid-Continent at Texas Drive

Joe B. Woods, Abbott Sparks, E. V. Perkins, J. E. Kastrop, John McDonald, Clyde Dillehay, Robert T. Mahoney, Richard P. McKey, Art Gilliam, Jess Adkins, Ed Sealey, Paul Mansfield, Joe C. Webb, Royal Courtney, Charles McKean, Sherwood Entwistle.

Reich Bros. Mfg. Company
West Area, South of Block 118

Reliance Electric & Engineering Company
North Area, Block 206

Remco Manufacturing Co.
North Area, Outside, Block 205

Pipeline equipment and supplies, holiday detectors, pipeline finders, dope pots, pipe cleaning machines and pipe benders.

R. M. Ransey, H. W. Bardsley, Davies Allport, H. J. Kratt, O. T. Homan, Van Arsdale, W. R. Rudolph, Jack Rasor ,Leo Tinker.

Ren Equipment Co.
Park Lane, Booths 31, 32, 33

Automatic controls for gas engines, diesel engines and gas compressors, oil level regulator systems and exhaust condensers.

George Boy, Billy Goan, L. D. Harbour, O. G. Houser, M. B. Llorente, Mose Quinn, L. S. Robb, S. D. Harman, Jr., H. G. Lawrence, D. M. Nelson, Al Dunn.

Republic Steel Corporation
Kansas Bldg., Booths 102 - 115

Republic Supply Co.
Kansas Bldg., Booths 99 - 101, 116 - 118

Representative group of materials and supplies distributed by Republic Supply.

M. N. Amsden, F. H. Anthis, L. Armatta, J. J. Augsburger, R. N. Bean, J. C. Bergin, P. W. Berry, A. Birdwell, R. L. Block, Jr., W. Chafin, W. W. Clift, D. L. Collins, H. R. Creech, W. J. Davis, H. L. Ellis, E. M. Frye, M. D. Gilmore, W. H. Goodman, H. H. Haire, A. C. Hazel, D. Hollyfield, R. J. Hood, Jr., H. G. Huddleston, C. J. Jump, C. L. Knoll, M. E. Liggett, E. P. Martin, A. McLawhon, G. V. McClintic, W. J. McWilliams, A. Mings, T. C. Mitchell, R. A. Prater, J. P. Rhodes, R. A. Riddle, J. E. Roberts, H. H. Rutter, E. F. Sanford, Jr., F. S. Spain, L. M. Stallard, D. A. Stanley, Jr., M. H. Suggs, G. M. Tope, B. B. Tunnell, R. E. Williams, K. A. Wood, J. F. O'Neill.

Reynolds Atlantic, Inc.
North Area, Booths 65W, 66W

Reynolds Metal Company
North Area, Block 207

Demonstration of hand and automatic welding on aluminum pipes, display of aluminum oil country pipe and heavy end pipe, and aluminum chemicals.

W. W. Beasley, Jr., W. B. Moore, R. D. Bryant, W. H. Caruthers, C. R. Scholl, D. E. Smith, I. C. Scott, L. E. Kuhnmuench, C. M. Robertson, R. J. Bennett, C. R. Durham, R. S. Edwards, J. L. Holcomb, R. S. Dalrymple, L. H. Hillman, L. E. Pennington, L. V. Sheain, L. S. Beeler, L. F. Wong, R. W. Flournoy, W. A. Condon, M. F. Finnerty.

Reynolds Oil Field Sales Company
Oklahoma Bldg., Booth 260

Riddle & Hubbell Company
Southeast corner of Cafeteria

The Ridge Tool Company
Texas Bldg., Booths 28 - 31

Wrenches, threaders, vises, cutters, reamers, power drives, pipe and bolt threading machines, Ridgoil.

R. C. Chamberlin, L. C. Richardson, Seth Smith, Oliver Perry, R. D. Fye, W. L. Parcell.

Roach Equipment Company
North Area, Booths 59N, 60N

Robbins & Myers, Inc.
North Area, Booths 52N - 55N

Rochester Ropes, Inc.
Texas Bldg., Booth 94, 95

Steel wire rope and allied products.

W. L. Rochester, Jr., K. Hellinger, W. Martin Kempe, L. A. Rhoades, T. I. Martin, Jr., C. A. Castillo, Jack Baker.

Rockford Clutch Div., Borg Warner Corp.
Oklahoma Bldg. Booths 74, 75

Rockwell Standard Corp., Transmission & Axle Div.
North Area, Block 204

John A. Roebling's Sons Corp.
S & T Bldg., Booths 69, 70

Wire rope and power and control cables.

Albert Neroni, E. G. Hart, W. A. Huber, D. W. Vernon, R. A. Hill, G. N. Volz, D. W. White, G. A. Knight, J. C. Barney, G. P. Hays, W. F. Hanline, R. L. Donner, F. A. Maskell, William Deas.

Rollway Bearings
Texas Bldg., Booths 84, 83

Rolo Manufacturing Company
Block V

Roots-Connersville Blower Div. Dresser Industries, Inc.
Dresser Bldg.

Rotary gas meters, rotary blowers, spiraxial compressors.

R. R. Newquist, G. H. Crocker, J. L. Hylton, D. R. Fulton, B. Feder, D. B. Hutchcraft, J. M. Maag, H. A. Jacker.

Ross-Martin Co.
S & T Bldg., Booth 13

Geological-exploration filing equipment and supplies.

J. M. Lanigan, John H. Thomas, H. A. Green, Fred Nichter, Alan Cook, Al Wickham.

Rotary Drilling Services, Inc.
California Bldg., Booth 55

Rotary Oil Tool Company
North Area, Booth 30N

Roto Hammer Company
Block 104

Rust-Oleum Corp.
Kansas Bldg., Booth 129

Rust preventive coatings.

Robert A. Fergusson, Otis B. Casanova, Beverly Casanova, Earl Lyons, Neal Noah, William C. Pace.

S

Salt Water Control, Inc.
Block 207, Outside Space

Mud degassers and desanders, clayjector for rejecting clays and recovering barite from weighted muds, and desander for water wells.

J. B. Baker, Jr., M. J. Brignac, D. R. Carter, O. M. Clayton, R. L. Erwin, R. W. Erwin, J. C. Forbes, W. H. Gandy, A. B. Grice, J. B. Jenkins, W. G. King, Winfred Lott, R. B. McCrone, Jr., Whit Mason, H. D. Mathena, W. J. Mathena, H. D. Mathis, J. W. Melton, R. L. O'Shields, R. L. Ritchey.

Schield Bantam Co., Inc.
Trinidad Trail and International Ave., Block 206

Carrier mounted, crawler mounted, and self-propelled crane excavators and various front end attachments.

Schlumberger Well Surveying Corp.
Block 105

Well logging and complete services.

W. J. Gillingham, E. F. Stratton, R. R. Rieke, C. R. Edgecomb, R. K. Thies, W. P. Biggs, C. Doh.

Scientific and Process Instrument Div., Beckman Instruments, Inc.
Texas Bldg., Booths 49, 50

Gas chromatographs, pH instrumentation and other process stream analyzers, spectrophotometers, laboratory and portable pH meters and other analytical instruments.

George Bailey, Roy Brown, Thomas Guerin, Mark Howlett, Marshall Melaun, Edward Pulsifer, Byrne Simpson, Robert Vanderveld.

Scientific Service Laboratories
Between V & Y on Dawson St.

C. V. Peterson.

Scott Industries, Inc.
Kansas Bldg., Booth 79

Industrial scale model parts, tools and materials for do-it-yourself three dimensional "drafting" plus custom model making.

Scott-Rice Company
Oklahoma Bldg., Booths 7, 8

Sealol Corporation
Silver Lane, Booth 41

Seismograph Service Corp.
S & T Bldg., Booths 75, 76

Well logging services which include those of its new division, Birdwell Incorporated, as well as its new CV logging services.

Sentinel Manufacturing Company
North Area, South of Block 203

Shaffer Tool Works
Oklahoma Bldg., Booths 1, 2, 76, 135

Hydraulic blowout preventers, drilling and fishing tools, Kelly cocks, adjustable flow beans.

Donald U. Shaffer, Elvin K. Wilson, John Vertson, E. C. Counts, Norman LeRoy, Roger S. Peterson, Charles D. Shaffer, Thomas A. Andrew, James W. Murray, Jr., Arthur E. Wilde, Lee R. Chisholm, Wilfred C. Gibson, W. Avery Brown, Frank A. Haynie, James R. Neill, Carl W. Vogt, Virgil W. Moon, James H. Plemons, Clay C. Fry, Sr., John D. Best, David C. Guinn, Joe Gaudiano, E. J. McCollum, Charles C. Weiss, I. D. Bennett.

Sherman Products, Inc.
North Area, Block 207

Robert A. Shuey Co.
S & T B'dg., Booth 14

Quick disconnect couplings and a rotary valve actuator.

Robert A. Shuey, Jr., Elwood H. Carpenter, Leonard M. Clark, Robert Johnson, Tom Welch, E. Carter Miller, Bob Lanman.

Sinclair Companies
Oklahoma Bldg., Booths 36, 37

Air conditioned service booth and a telephone.

Skelly Oil Co.
Kansas Bldg., Booths 3 - 6

Illustrated panorama of the petroleum industry — from exploration to marketing.

Jess Howard.

Skinner Brothers
Kansas Bldg., Booths 56, 57

SKF Industries, Inc.
Texas Bldg., Booths 67, 68

Smithco Engineering, Inc.
Block 203 (South)

Air cooled heat exchangers and related temperature control equipment.

O. L. Smith, J. H. Lee, R. A. Darling, Roy H. Smith, R. L. Kinney, R. R. Yenter, Jack Simpson, Brock Mott, Fred Mott.

A. O. Smith Corporation
Booths 143 - 146, 185 - 188

Meters and service station pumps, line pipe and casing, commercial water heaters, vessels and heat exchangers, welding machines and supplies, electric motors.

H. C. Smith Oil Tool Co.
California Bldg., Booths 10, 11

Rock bits, hole openers and rock bit lubricator.

A. S. Marshall, K. H. Swart, H. G. Bentson, F. E. Siever, E. Kunnemann, M. Martin, W. Brant, C. Holt, M. Evers, E. Griffin, W. R. Faulk, J. Bouterse, W. Curlee.

Solar Aircraft Co.
North Area, Block 205

Gas turbine engines and expansion joints.

W. F. Briney, F. Q. Wilson, O. M. Sievert, G. W. Clark, R. M. Horlock, W. J. Emery, R. H. McDaniel, H. R. Ehlers, R. K. Donovan, H. C. Donahue, W. O. Flascher.

Sooner Pipe & Supply Corp.
North Area, Booth 90

Hospitality facilities.

Sam Zarrow, Henry Zarrow, Jack Zarrow, Sidney Selinger, Jean Brown, Larry Ludiker, Doil

Maxwell, George Spencer, Leo Mullens, Kenneth Grimes, Charles Brown, Gene Franklin, Walt Ware, Dick Pickens, Lyle Wells, P. B. Martin.

South Chester Tube Co.
Oklahoma Bldg., Booth 77

Asbestos-cement pipe, and asbestos-cement gate valve.

Francis H. Gibson, Johnie Steele, Eddie Mosley, A. B. Creecy, Geo. Foreman.

Southwest Oilfield Products, Inc.
Oklahoma Bldg., Booth 59

Fluid end mud pump parts, pistons, rods, renewable sleeve pump liners and steel to steel retainment of pump liners, with a positive packing seal, through use of fluid cylinder heads and renewable sleeve pump liners.

Arthur L. Leman, Howard N. Landgrave, Jack Voss, Sam Sillavan, Ray Williams.

Southwest Wheel, Inc.
West Area, Block 114

Southwestern Bell Telephone Co.
Kansas Bldg., Booths 44, 45, 60, 61

Southwestern Industrial Electronics Co., Div. of Dresser Industries, Inc.
Dresser Bldg.

Seismic magnetic field recording and office data reduction systems; pipeline dispatch console and telemetering transceiver, miscellaneous test and process control instrumentation; fabricated custom trucks, trailers and skid units.

Keith R. Beeman, Richard H. Parker, Warren C. Dunn, M. C. Hester, Rex Grey, Ralph P. Watkins, Terry W. Russell, Frank G. Gass, John Pink, Louis B. McManis, Billy F. Mitcham, Ernest A. Pratt, W. R. White, J. Pat McGrew, Albert B. Dustin, Al Boynton, Charles R. McLendon, John Joss.

Southwestern Porcelain Steel Corp.
West of Block "S"

Spang & Co.
California Bldg., Booths 60, 61, 44, 45

Cable drilling jars, bits and rope sockets, and fishing tools.

O. B. Pierce, F. J. Ripper, M. G. Decker, George A. Fish, H. L. Taylor.

Spartan Aircraft Company
West Area, Southwest corner of Block 120

Standard Magnesium Corp.
S & T Bldg.

Corrosion control equipment, magnesium anodes for corrosion prevention of oil storage tanks, oil casing, refinery vessels, etc.

D. H. Burton, R. M. Wheeler, Joe Pitts.

Standard Safety Equipment Co.
North Area, Booth 2N

Safety equipment and clothing, welding tarpaulins and welding curtains, face and eye protection.

George G. Dickson, Robert J. Dee, Maynard Page, George Walnez.

Stardrill-Keystone Co. Div. of Koehring Co.
North Area, Block 204

Rotary drill with water-cooled piston-type compressor and mud pump.

Harold J. Ruttenberg, Howard D. Barnhart, T. M. Greene, Claude Bonham, H. J. Allen, Robert C. Johnston.

L. S. Starrettt Company
Oklahoma Bldg., Booths 226, 227, 228

Steffan Mfg. Corp.
Park Lane, Booth 11

Mechanical draftsman pipe contouring machine, mechanical hole cutter, specialized custom made burning equipment.

S. A. Grubish, R. B. Grubish, Wray Scott, Don Middlehurst, John McKissick, H. Maynard, E. A. Daniels.

Stewart & Stevenson Dist. Co.
Block 122, upper half

Blowout preventers and hydrostatic testing units.

Paul Koomey, Calvin Hohle, Joe LeMoine, Bonner Riley.

Stewart & Stevenson Services, Inc.
East of Block "V"

Stewarts and Lloyds
North Area, Booths 78N, 79N

Joe Stine
North Area, Booth 12N

St. Louis Cordage Mills
Texas Bldg., Booth 89

Stockham Valves & Fittings
S & T Bldg., Booths 15, 16

Valves and pipe fittings.

C. H. Denicke, W. E. Jones, C. S. Coleman, Dan C. Vernon, Jack Mitchell, James W. Anderson, Jesse E. Burkhalter.

Stratoflex, Inc.
Texas Bldg., Booths 97, 98

Swepco Tube Corp.
Oklahoma Bldg., Booth 212

Large diameter high alloy pipe and fittings, welded pipe and steel shrouded polyvinyl chloride pipe.

C. J. Harney, A. Cella, H. Hawkins, C. Nichols.

Synchro-Start Products, Inc.
S & T Bldg., Booths 3, 4

T

Teale & Company
North Area, South of Block 204

Technical Oil Tool Corp. Ltd.
Oklahoma Bldg., Booths 192, 193

Templeton, Kenly & Co.
Texas Bldg., Booths 42, 43

Mechanical and hydraulic jacks, center-hole and solid portable hydraulic pullers, push-pull and two and three grip pullers.

A. C. "Art" Templeton, W. D. "Bill" Boldt, P. H. "Phil" McManus.

The Thew Shovel Co.
North Area, Block 204

Crawler hoe, crane, 4-wheel drive front end loader and crane booms.

C. S. Weber, G. E. Gunther, F. A. Williamson, T. R. Engquist, F. Johnson, D. L. Douglass, J. L. Beltz.

Thompson Pump Co.
Oklahoma Bldg., Booth 132

Sub-surface oil well pumps and accessories.

R. D. Thompson, Frank Wilcom, J. R. Thompson, E. H. McCune.

The Thompson-Ramo-Wooldridge Products Co.
Kansas Bldg., Booths 95, 96

Digital control computer.

Lewis O. Ward, Jr., William C. Snyder, Richard N. Hexter, Ray J. Stanish, Bertram R. Newman, Francis G. Semere, Raymond E. Jacobson.

Thompson Tool Co.
North Area in Block 207

Shale separators and shale shakers.

L. L. Thompson, Joel Cathey, Joe Bell, I. W. Corder, Walter Spruiell.

Thornhill-Craver Co., Inc.
Kansas Bldg., Booths 67 - 72

Christmas tree manifolds, gage valve and connector, Christmas tree fittings, positive and adjustable chokes and wing valves, tees, crosses, Christmas tree caps miscellaneous couplings, flexible ball joints, big inch couplings, malleable iron couplings and fittings, jet type strainer for water filtration, hi-low surface safety valve, scraper trap closures, blowdown fittings, jet type fluid strainer.

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North Area, Booth 28N

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Tracerlab, Inc.
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West Area, Block 121

Tube Turns, Inc.
Block "A"

Tuboscope Company
Texas Bldg., Booths 1, 2

Tubos DeAcero DeMexico S. A.
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Tubular Lining Corp.
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Union Oil Company of California
Kansas Bldg., Booth 32

Union Steam Pump Sales Co.
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Union Switch & Signal
Division of Westinghouse Air Brake Co.
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Union Tank Division, Butler Mfg. Co.
Block "H"

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Texas Bldg., Booths 80 - 82, 129 - 131, 66

Unit Rig and Equipment Company
Adjacent to Block 3

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North Area, Booths 67N - 69N

United States Motors Corp.
North Area, Booth 202

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United States Steel Company
Block 2

United Supply & Mfg. Company
California Bldg., Booths 28, 29
and Southeast of California Bldg.

Universal Oil Products Company
S & T Bldg., Booths 73, 74

Universal Packing & Gasket Co.
California Bldg., Booth 16

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Vapor Recovery Systems Company
Oklahoma Bldg., Booths 69, 70, 71

Varel Manufacturing Company
North Area, Booth 49N

Velocity Power Tool Co.
Oklahoma Bldg., Booth 115

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Wichtex Machinery Company, Inc.
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Williams Brothers
Oklahoma Bldg., Booth 195

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Wilson Manufacturing Co., Inc.
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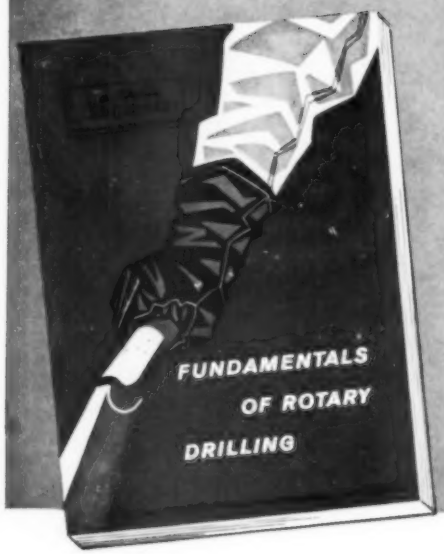

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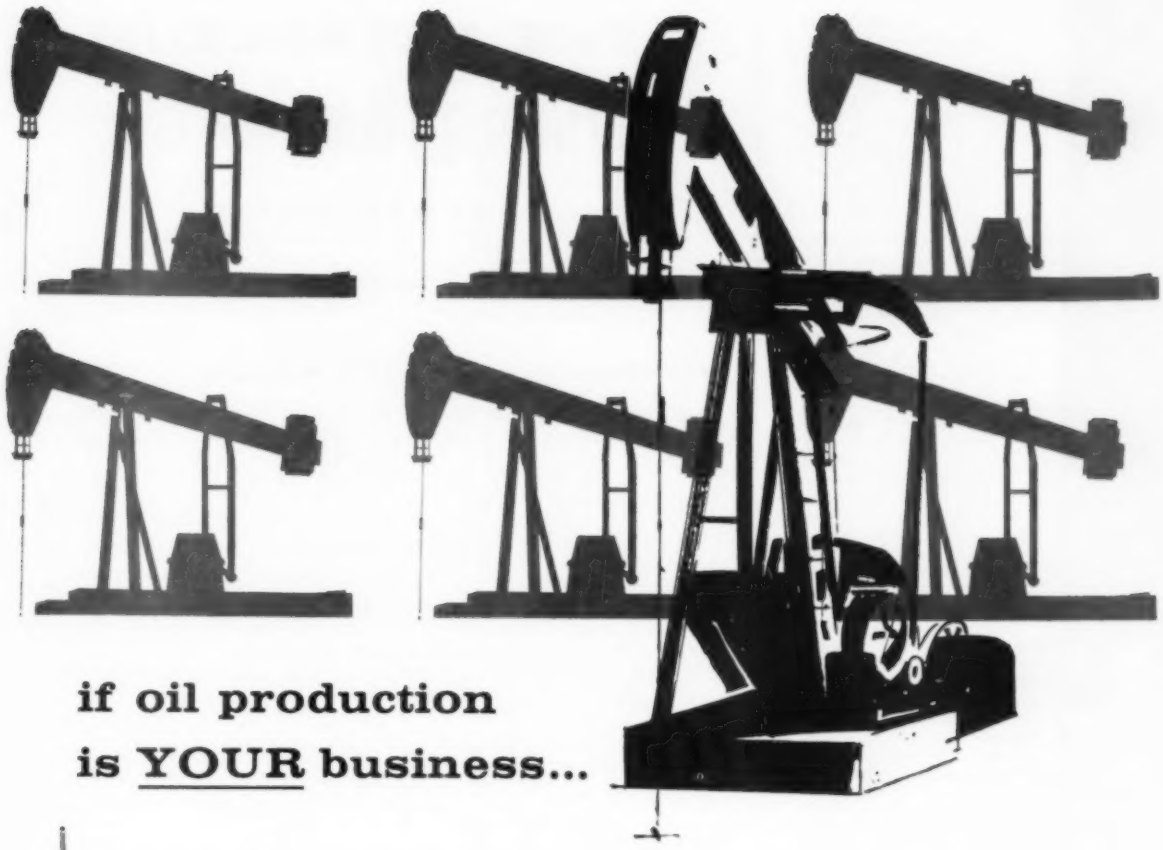

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THE PETROLEUM Engineer

FOR MANAGEMENT

NUMBER 4 • VOLUME XXXI • APRIL, 1959

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THE PETROLEUM Engineer
INTEGRATED EDITION OF THE PETROLEUM ENGINEER

THE PETROLEUM Engineer
SPECIALIZED EDITION OF THE PETROLEUM ENGINEER

REFINING Engineer

PIPELINE Engineer

What Do YOU Do in Emergency?

THE TEMPERATURE of the war between the Dictatorship of the Proletariat and the Free World is never static. It moves from hot to cool, from warm to cold. The most optimistic hope it will go into a real freeze. The alarmists expect a blazing caldron; the realistic some scattered fires.

Nobody knows for sure.

The question is: What do you and your company do in case of emergency? In the past there has always been at least some time to plan — there may not be in the future.

The record of the oil industry has been amazing in times of crises. In World War II, in the Iran fracas, in the Korean War, in the Suez mishap — these emergencies have brought out the best qualities of the U. S. and Free World industry.

It's flexible because it is not one big federal monopoly or even a score of big companies — it is thousands of companies of all kinds and sizes and shapes — all with initiative, energy, ideas, and ability.

It has strength and courage because it is made up of individuals who have fought and come to terms with nature's eccentric demands upon those who would take and make useful her resources.

(This strong character of the industry develops intra-industry battles in milder times that may be corrosive as is generally believed, but we've always been inclined to the idea that these continual skirmishes kept the troops on their toes — if the spectators would only stay off the field.)

HOW QUICK would the industry react in a holocaust?

The National Petroleum Council could probably answer that better than any organization. But the answer could come down to your area, to your company, to — *what would* YOU *do?* Have you studied the possibilities that may arise? Have you obtained all the information that could help you? Have you looked into the Emergency Management course offered by Industrial College of Armed Forces? (See *The Petroleum Engineer*, September, 1958, Page E-5.)

Only sublime idiocy would bring on an all-out war but the commodity cannot be sold short on the present market. More likely to come, however, are flares dropped here and there that could deplete cooperation and good will among companies that haven't been exercised heartily in recent months.

A holocaust would unite us like a strong catalyst. It's the area battles that could bring schisms so wide a contractor couldn't throw a pipeline across them.

Are you prepared for an emergency? Are your fences mended, your cattle branded, your neighbors friendly? Can we say to our government in crisis — "You don't need to take care of us — we'll do our part."

In all the world only the U. S. petroleum industry *could* say that and deliver.

Can we keep it that way?

Ernestine Adams

Congrats and $25 to Billy D. Brown, T.P. Coal & Oil Co., P. O. Box 4067, Midland, Texas

Since the petroleum industry made its lusty entrance with the Drake well a century ago . . some remarkable records of achievement have been chalked up by oil and gas men.

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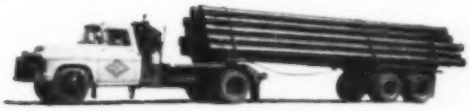
Lone Star is a round-the-clock quality operation. You can depend upon Lone Star API casing, tubing and line pipe.

Neighbor, wherever you are, specify Lone Star and we both get a good deal.



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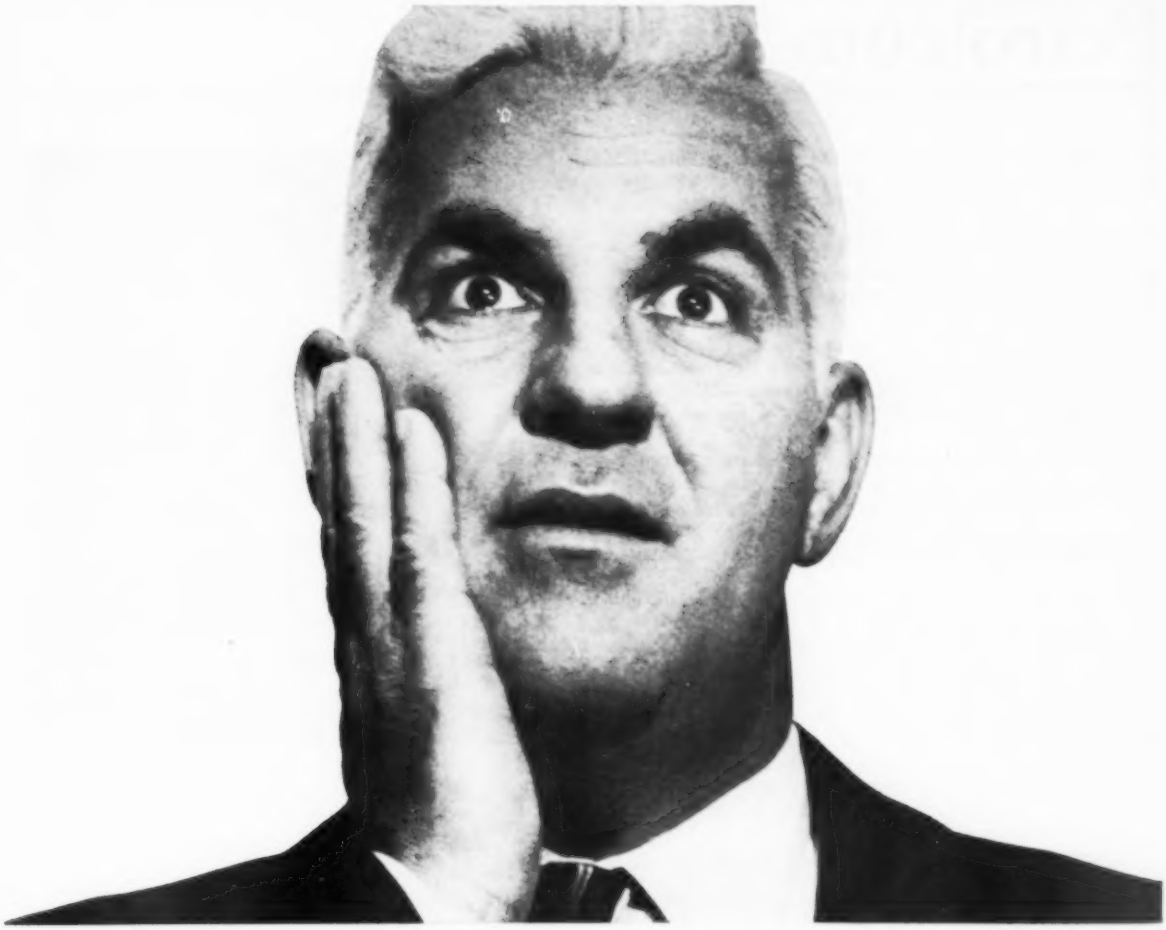

He's just had a preview of the new machinery "Oilwell" will exhibit at I.P.E.

. . . and it's truly an exciting view to behold! New process pumps and other new equipment for refinery use . . . new gathering line pumps and new compressors for pipe line applications . . . new pumping units, new waterflood pumps and other new machinery for production . . . and new drives, new draw works, new mud pumps and other new equipment that will delight the drilling industry.

Oil Well Supply is going all-out to get the oil industry's second century off to a fast, efficient and profitable start . . . with new products designed to work better, longer, and more productively.

You must be sure to visit "Oilwell's" Exhibit at the International Petroleum Exposition in May. No matter what branch of the oil industry you are in, you will find products that will help you do your job better, faster and more efficiently.

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Petroleum Profile

WHAT MAKES a company grow? The answer is easy. It's the men who manage it. So when you think of Monterey Oil Company, you think of Howard C. Pyle, who in a few short years has developed a successful company.

In Monterey's first five years of operating life, from 1953 to 1958, inclusive, gross income increased 270 percent; net income was up nearly 200 percent, and the company's organization went from 152 to 402 employees.

"We are composed almost exclusively of professionals," Monterey's president enjoys telling. "We have geologists, petroleum engineers, lawyers, accountants — all professionals. This is a trend — certainly in the oil business — the professional company."

Howard Pyle is a specialist turned executive. Born in Williams, Arizona, he was only a year old when his parents moved to Pasadena, California, where he graduated from high school. He received his BS degree is petroleum engineering and geology from the University of California in 1926.

His first oil job was with Union Oil of California and the company immediately sent him to Venezuela for a couple of years in 1927-28. Back from there he was sent to Canada on exploration. He had married Linda Elfrida Klamroth in 1930 so it was a blow in 1931 when Union Oil, among others, had to lay off a large group of geologists and engineers, and young Pyle was one of them. He managed another job pretty quickly and spent over a year in mining operations in California and Nevada. He liked the oil business better. Isolation of the mining community made advancement seem far off, too.

He returned to Union Oil and began his climb to chief production engineer with the company. He didn't stop study and in 1939 received a Master of Science degree in petroleum engineering from the University of Southern California. A couple of years later he was awarded the professional degree of petroleum engineer from the same school.

When the war came Pyle was one who found his proper niche. He went into the Corps of Engineers, U. S. Army, and was assigned to petroleum matters in Washington. In 1944 he went to London as petroleum officer on General Eisenhower's staff.

Lt. Col. Pyle was in the June attack in occupied France, on the staff of General Montgomery, who commanded the invasion troops.

It is typical that oilman Pyle came home from the wars on a tanker.

"Petroleum was the only completely interchangeable product in the war," he recalls with pride. "Allocation and supply could be worked out with some confidence." Nearly all other suppliers were far from standardized. Every nation's soldiers had to have different food, ammunition, tires, trucks — none were standard in size, type, etc.

Back in civilian life, Pyle's career took a new turn. He became a vice president of Bank of America, in charge of oil loan department. At the time the Bank of America expected to have a task finding enough borrowers in regular channels, but the trend soon changed and the oil loan department didn't expand a great deal. After two years Pyle became president of Continental Consolidated Corporation, a producing company. He established his own consulting firm when this was sold. In 1951 Jergens Oil Company was purchased by a syndicate with the idea of selling off the properties. Put in Howard Pyle's capable hands, he helped persuade the group to organize a company for acquisition

HOWARD C. PYLE
President
Monterey Oil Company

instead of liquidation. He was made president, director, and chairman of the executive committee, and he still holds all three jobs.

"Monterey is a professional exploration company," he'll tell you, "but growth by discovery is a difficult path. We also purchase properties."

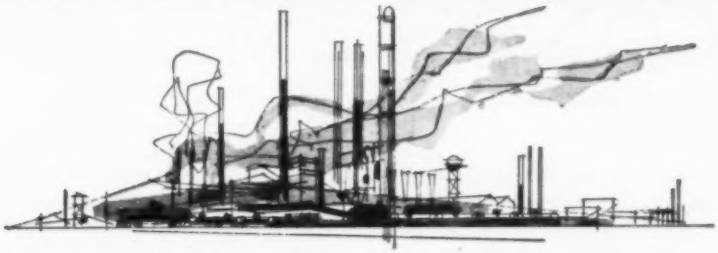
It isn't only properties that have been acquired but also management. Pyle thinks Monterey had some advantage in going out and picking its top management. "Some fine people were found in companies we absorbed," he said. Now he feels that the company itself has enough depth to fill advancements from the ranks.

Pyle is an outdoor man and looks it. His early geological and mining work kept him there and now he seeks it for recreation — hunting and fishing (especially marlin in Mexico waters). His interest in photography adds to the zest of his favorite sports.

Jane Pyle Jones and Carter Pyle, the two children, both have homes of their own now. Jane, who has a master's in education from Stanford, recently married. The only son, Carter, who is a petroleum engineer graduate of Stanford, lives in Southern California. He and his wife have two children.

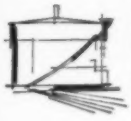
The president of Monterey is important in the industry as well as to his company. He is a director of API and Western Oil and Gas Association. He belongs to several geological and scientific societies, and is a member of Pi Epsilon Tau, an honorary engineering fraternity.

In February 1959, Howard Pyle became president of the 30,000-member, 88-year-old American Institute of Mining, Metallurgical and Petroleum Engineers. He has already served AIME in several capacities; in 1947 he was chairman of the Petroleum Branch.



General American does a lot more than just build tank cars

General American's design, engineering, fabrication and erection facilities are available to solve many processing and storage problems. Here are some of the products and services offered.

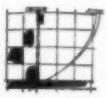


Conservation Structures

Tanks of all types for every kind of liquid. Cone roof structures and eight WIGGINS CONSERVATION SYSTEMS including floating roof types with the famous WIGGINS safety seal that reduces fire hazard and eliminates losses from thermal breathing.

Kanigen® Chemical Plating

When your equipment must resist corrosion and abrasion, investigate KANIGEN® nickel alloy coating. From process equipment to tank car interiors, KANIGEN does the job economically and efficiently.

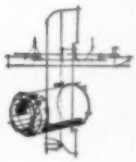


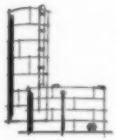
Gasholders

WIGGINS gasholders with patented dry fabric seal. No operating costs, no maintenance problems with the safest of all gas storage structures. Store practically every type of gas in commercial use safely and economically.

Custom Fabrication

All types of vessels, structures and weldments manufactured in our plants to meet all code specifications. Our engineers are on call to help you.



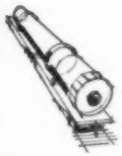


Water Storage

Standpipes, reservoirs and tanks are fabricated in our plants and erected by our specially trained crews

Field Erection

The Field Erection Division maintains experienced crews and modern, efficient erection equipment throughout the country.



Process Equipment

Louisville Dryers, Turbo-Mixers and process equipment of many types including RDC columns for extraction and reaction processes. Our experienced engineers will work with you on design problems. You can test processing ideas in our laboratories. You can rent pilot-scale dryers, mixers and columns for tests in your plant.

Strategic Locations

There is a General American plant in your area. Plants are located at Sharon, Pa.; East Chicago, Ind.; Birmingham, Ala.; Orem, Utah and Compton, Cal. Call us. You'll find ***it pays to plan with General American.***

Process Equipment Division *Plate and Welding*

GENERAL AMERICAN TRANSPORTATION CORPORATION

135 South LaSalle Street • Chicago 90, Illinois

THE CONFERENCE TABLE

An economy runs best when economic theory is least. ANON.

More "Manager" Articles Coming

This month we gave way to the International Petroleum Exposition Guide Book and will continue our series on "How to be a Manager" in the next issue.

We were interested in a survey of Dun's Review and Modern Industry of 160 presidents panel. Opinion of one out of every five men in the group was "We are breeding a race of frightened men, of payroll cowards guided by their associates' approval. This is a death sentence for bold and energetic people."

Of course the one in five is a minority. These saw a very real danger that as the corporation grows and its internal organization becomes more complex, management personnel at every level tends to become submerged as individuals and reduced to playing the role of follower.

These are not the kind of men needed to lead the petroleum industry in the rough years ahead. In our "How to be a Manager" series we hope to reach some of those people with the determination, the ideals, and the ability who — perhaps because of their non-conformity — have not been tapped by present management.

Most presidents on the Dun's Review panel, however, said that a happy mixture of individualism and conformity make the most capable executives. They argue that the executive, no less an individual simply because the bigness of the organization makes it necessary for him to make decisions on facts supplied from many sources, still retains his initiative and decision-making ability.

There is, however, a pressure for conformity in big business today which confronts the individual personality. Sometimes this refines the rugged individualist; it could develop any "organization man" who exists only as a part of the organization. Our series has the approach of the individual to the job — not the viewpoint of the organization to the individual.

Are Petroleum Engineers Part of Management?

In the petroleum industry, engineers appear to make up the biggest portion of management although no survey has been made on this precise point. From observation we believe this is true throughout middle and top management. There is no question about the fact in operating departments, in exploration, producing companies, and transmission companies. These are heavily staffed by engineers on the management side.

Not all engineers advance steadily — some not at all — but in several large companies the majority of the top executives and directors began as engineers. With present knowledge, then, we'd say that engineers in every phase of the petroleum industry are not only part of management, but the largest part. (You'll find some argument on page E-10.)

Prunes and Plastics

Phillips Petroleum's Marlex has taken on a premium-incentive buying job. The "Sunshine Jar" made of rigid polyethylene, was introduced by California Prune Advisory Board. With a label from any brand of California prunes and $1.25 you can get a gold plastic jar unaffected by boiling water and/or by storing in refrigerators.

More 100-Year Anniversaries

In this year of the 100th Anniversary of the Oil Industry there are no oil companies we know of that began in 1859. We find, however, that some of the supply companies for the industry have reached 100 years or close to it. Gardner-Denver, which was founded in Quincy, Illinois, in 1859, supplies drilling equipment and production tools for oil rigs, pipelines, refineries, and construction jobs. At the time the company was organized, however, it was not making tools especially for the petroleum industry. If you know of any other suppliers who have been carrying on since 1959 we'd like to hear about them.

★ *Some folks don't look up until they are flat on their back.*

Industry's Purchased Power

A survey to determine the increase in use of utility power by the petroleum industry was made by Petroleum Electric Power Association and reported last fall. The results are of interest, especially as power load is given by division. The trend to purchased power shows a strong upturn over the period, increasing sharply in more recent years.

For reference here are the figures:

Petroleum Electric Power Association Survey Sheet
Annual sales to the petroleum industry
in thousands of kwh

Year	Oil & Gas Refining	Pipeline Pumping	Oil Well Power	Total Petroleum Industry
1930	45,697(2)*	93,860(3*)	102,976(7)*	242,533(8)*
1931	48,570	86,031	68,666	203,267
1932	40,041	70,294	46,644	156,979(6)*
1933	33,068	72,037	62,284	167,389
1934	48,934(4)*	65,992	109,059(3)*	223,985(7)*
1935	119,763(6)*	107,560(6)*	175,090(8)*	402,413(9)*
1936	140,022(7)*	132,442(8)*	204,021(6)*	476,485(10)*
1937	157,931	165,173	283,853	606,957
1938	143,662	118,670	259,621	521,953
1939	142,999	89,833	260,161	492,993
1940	154,650	104,481	269,658	528,789
1941	207,829(8)*	131,552	282,245(7)*	621,626(11)*
1942	220,931	154,374	280,940	656,245
1943	352,320(10)*	329,477(11)*	340,571(9)*	1,039,333(16)*
1944	432,435	434,145(12)*	377,042(12)*	1,262,396(17)*
1945	471,046	417,192	393,945(12)*	1,311,417(18)*
1946	501,791(12)*	388,418(14)*	362,430(14)*	1,368,667(20)*
1947	524,568	478,670	388,954	1,511,941
1948	602,118	590,993	396,846	1,721,465
1949	644,963(13)*	799,627(16)*	446,205(15)*	2,005,626(22)*
1950	710,226	942,069(17)*	543,252	2,339,483
1951	763,942	1,228,779	703,282	2,891,767
1952	907,048(14)*	1,413,228	768,314	3,295,939
1953	1,208,665(18)*	1,302,167(18)*	1,001,506(16)*	3,756,718(33)*
1954	1,551,425	1,340,226(19)*	1,213,878	4,396,753
1955	1,738,144(19)*	1,530,902(21)*	1,495,424(18)*	5,140,342(28)*
1956	1,943,466	1,720,104	1,749,279	5,783,657
1957	2,190,198	1,851,432	2,067,667	6,500,271

* Number of companies reporting.

Engineers Vote for Union

Engineers and architects at the Chicago office of Standard Oil (Indiana) voted 18-to-9 for union representation through the Research and Engineering Professional Employees Association. The group voted for "no union" in 1957, in breaking away from representation by the Central States Petroleum Union. REPEA represents approximately 550 professional employees at the company's plant in Whiting, Indiana.

★ *Politeness is to human nature what warmth is to wax.*
—Arthur Schopenhauer

Wage Supplements Rise

Steel companies are encountering the same record increase in employee benefits that have begun to worry petroleum management. In *Steel Facts*, a publication of U. S. Steel, a graph shows that between 1947 and the late months of 1958, steel workers' straight-time pay had doubled, but their wage benefits had increased about 4½ times. They are now 75 cents an hour, more than 20 percent of the total hourly wage cost. This is a leap from the 17 cents per hour wage supplement paid in 1947.

Part of this overall increase is attributed to the three-year union-management agreement that went into effect in mid-1956. Instead of the individual now taking care of his retirement, his illnesses, his savings for a rainy day, the company has taken over these duties.

★ *You can do a lot for an old house these days if you're handy with money.*

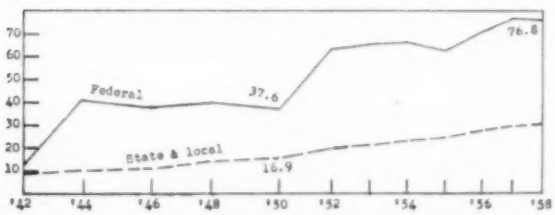
The Man Who Can't Be Right

"On the off-chance that some of you have been searching for oil during the past year or two, you may have missed some of the profound statements that have been made on the subject of oil imports by such closely allied groups as the various independent oil and gas associations, the major oil companies, the National Coal Association, the National Oil Jobbers Council, and the governments of several foreign nations — as well as by several thousand producers, refiners, consumers, free traders, protectionists, Colonel Drake, and Zsa Zsa.

"Taking the last first, Zsa Zsa said, 'Oil is where you find it, beeg boy.'

"Colonel Drake said, according to a message I recently received from the spirit world, 'Boy, I didn't know what I was letting you in for'."

Captain Matthew V. Carson, Jr.,
before AIME, San Francisco, February, 1959.



The most dramatic development of the past 50 years has been the reversal of positions between local and federal governments. Combined state and local tax revenues began consistently to fall behind federal takes only after 1942. The dominant position of the federal government since 1942 has never been reversed — and continues to grow. Conclusions: If state and local government are not to break down, they must find the courage to tax more — not waiting for federal reductions, which just won't happen, so says Economic Affairs, published by New York University.

How to Keep Your Car Running Smoothly

By James A. Hodges

1. Check battery water every month.
2. Clean spark plugs every 5000 miles. Change spark plugs every 10,000 miles.
3. Check distributor every 5,000 miles.
4. Clean air filter every 2000 to 5000 miles.
5. Change oil filter every 5000 miles.
6. Change motor oil every 1000 miles.
7. Change radiator water twice a year. Use anti-rust material.
8. Lubricate:
   Chassis — every 1000 miles.
   Wheel bearings — every 10,000 miles. (Take front wheels off.)
9. Tires: Keep right amount of air. Don't use tires without tread. Rotate tires every 5000 miles (sometimes called X'ing tires).
10. Brakes: Check at once if not in top shape.
11. Lights: Keep clean and check.
12. Change windshield wiper blades.
13. Steering: Same as brakes.

Ten Cannots

1. You cannot bring about prosperity by discouraging thrift.
2. You cannot help small men by tearing down big men.
3. You cannot strengthen the weak by weakening the strong.
4. You cannot lift the wage earner by pulling down the wage-payer.
5. You cannot help the poor man by destroying the rich.
6. You cannot keep out of trouble by spending more than your income.
7. You cannot further the brotherhood of man by inciting class hatred.
8. You cannot establish security on borrowed money.
9. You cannot build character and courage by taking away man's initiative and independence.
10. You cannot help men permanently by doing for them what they could and should do for themselves.

From U.S. News and World Report.

★ *Iron rusts from disuse, stagnant water loses its purity and in cold weather becomes frozen; even so does inaction sap the vigors of the mind.* —Leonardo da Vinci

Cheaper to Pay

In the new fiscal year the U.S. will pay $8.1 billion interest on our national debt. Congressman Jim Wright of Texas stated in the House that when all interest reached 3.5 percent we'd pay $9.8 billion a year. Approximately 11 cents out of ever $1 paid in federal taxes would go to carrying charges on the national debt.

Wright proposed that a plan be set up to pay off the debt in 100 years at the rate of $2.8 billion a year. This would require $283 billion of principal and $495 billion in interest, a total of $778 billion.

Aw, Congressmen, we just owe it to ourselves — or is it our great, great grandchildren?

HIGHLIGHTS ★ ★ ★

Digest of News and Comments

Count Highway Costs First

"Congress is being asked to decide whether or not you're paying enough taxes to take care of building the new 41,000-mile Interstate System. One question NOT under discussion is whether or not the states are practicing construction economy," suggests the Asphalt Institute in a recent advertisement. "Yet, this is the crux of the matter. The fact is: The finest highway your tax money can buy — a modern asphalt-paved highway — saves up to 10 percent — and sometimes up to 50 percent to build. Billions could be saved if Interstate Highways were built with asphalt pavement. *Billions!* Major savings in maintenance costs would result, too," the Institute concludes.

Oil Workers Gain Uranium Unit

The Oil, Chemical Atomic Workers International Union has been successful in an initial attempt at representing workers in the uranium processing industry. The OCAW is to become the bargaining group at Phillips Petroleum Company's uranium mill near Grants, New Mexico. Five unions are competing for representation at nearby Kermac Nuclear Fuels Corporation.

Log Analysts Organize

Well log analysts may soon be members of their own specific engineering profession. Log analysts representing several major companies have named the first slate of officers and approved by-laws at the Tulsa meeting on March 12 to establish the Association of Professional Well Log Analysts. Individuals and groups throughout the U. S. are at work organizing chapters and study groups. The APWLA, setting medical association-type standards for its members, will conduct, correlate and evaluate logging research projects, publish a technical journal, exchange information, and will assist employers and companies in locating analysts.

Conoco Expands in Midwest

Continental Oil Company, which has offered to purchase International Refineries, Inc., and Western Oil & Fuel Company, is following a consistent pattern of growth and decentralized management. The proposed purchases, yet to be approved by shareholders, will continue under the present names, retain existing brand names, and operate under the same management and personnel. International operates a 15,000 bbl-a-day refinery at Wrenshall, Minnesota. Western markets products at 300 service stations in Minnesota, North and South Dakota, Iowa, Wisconsin and Canada. Both companies have production in Wyoming and North Dakota.

See the Petroleum Engineer, Pipeline Engineer, and Refining Engineer exhibit at

1959 WORLD PETROLEUM CONGRESS

NEW YORK

Warring Over Price Wars

First government attack on geographic price discrimination in gasoline sales has been launched in the form of a tentative order by Federal Trade Commissioner R. L. Piper. "First Blood" was taken at the expense of Pure Oil Company, in a ruling forbidding the company from cutting gasoline prices in any market where it competes with other brands, unless the company also reduces prices proportionately in all its sales territories. Pure has already filed an appeal to the full commission. If FTC should uphold the order, it could set a precedent for similar action against "discriminatory" price cutting by other major companies.

Oil Shale Interest Rises

Although the government has suggested that it may scale-down its proposed atom blast in attempting thermal recovery of shale oil in Colorado, more major companies are taking leases in oil shale areas in the Rocky Mountains. A new report on government activity in the field has been published by the Bureau of Mines and is making a concerted and individual appeal to oil and chemical companies for financial and "moral" support for its nuclear experimentation. Some industry observers claim any actual development in shale oil recovery would depend on either: (1) Continued rise in domestic oil producing costs or (2) a national emergency that would overshadow current expense justifications.

Union Oil Chops Western Postings

Union Oil Company of California acted March 1 to set the stage for the largest crude price reduction made during recent years. On that date the company announced reductions of from 1 to 60 cents a bbl in the price it pays for California and Four Corners crude oil. Reese H. Taylor, chairman of the Board for Union, stated that the move was "dictated by economic facts of life that no longer can be ignored."

First to protest the drastic cuts was the Oil Producers Agency of California. Executive Vice President Fox of OPAC stated: "Obviously price cuts of such magnitude can do nothing but further depress an already depressed California oil producing industry."

More Economy Necessary

An economic vise of rising exploration and production costs versus declining return per dollar spent, lower allowables and a general downtrend in selling prices, has the domestic oil industry in a "squeeze" that demands concerted effort toward even greater economy of operations, states E. B. Miller Jr., vice president of Southern division, Tidewater Oil Company. Miller is chairman of the general committee of the Oil Industry Conservation Forum. The OICF was formed last year to study conservation statutes and regulatory practices and to develop and recommend changes, "which will enable the industry to develop and produce its oil at a lower cost," said Miller.

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Plan now to attend...and bring your key men with you. Just one idea picked up here will make their visit worthwhile. For advance registration and hotel information write the Exposition at 480 Lexington Avenue, New York 17, N. Y.

5th

WORLD PETROLEUM CONGRESS EXPOSITION

New York Coliseum June 1-5, 1959

Management: International Exposition Co.

NPC to Study Emergency Mobilization

Walter S. Hallanan, chairman of the National Petroleum Council, has also taken on the chairmanship of the Committee on National Emergency Oil and Gas Mobilization, which is one of the important studies requested by the Secretary of Interior. Two other studies to be made are Use of Radio and Radar (under chairmanship of Morgan J. Davis, president, Humble) and Petroleum Storage Facilities (headed by R. L. Milligan, president, Pure Oil).

Under the new set-up Captain Matthew V. Carson, Jr. is co-chairman of NPC. He named Hans C. Jensen of the Office of Oil and Gas, Department of Interior, as co-chairman of the two latter committees and Frederick S. Lott, assistant director Office of Oil and Gas, as the Emergency mobilization co-chairman.

Hoffa Tries for Esso Unions

James Hoffa, of the Teamsters, is making an effort to organize the independent unions working for Jersey Standard. He has talked to refining unionists at Elizabeth, New Jersey, and at Baton Rouge, Louisiana. "Until the majority of all Standard Oil workers are under contract to one union, the company will continue to exploit its workers" he said.

Oil Prices Can Be Curbed

With dangerous price drops in crude oil it's ironic to see that the mandatory oil imports control program is accompanied by a move to curb prices. Under the decree the government will scrutinize all price increases posted on oil, its products or derivatives, from now on. If the price increases are considered too high more imports of crude oil will be allowed. So the oil industry gets its regulation both ways—a system of import restrictions and a cap on oil prices.

Whether the mandatory controls will prove more efficient than the voluntary system is still to be demonstrated. For areas east of the Rockies, the new quotas are 750,000 bbl per day of crude oil and unfinished oils, compared with 883,000 bbl per day under the voluntary system. For the West Coast new quotas are 195,000 bbl daily, down from the voluntary ceiling of 221,000 bbl per day. This includes only 8000 bbl of finished oil products.

Centennial Shenanigans

Can you imagine greetings from the governors of several western and mid-western states shipped across the nation through oil pipelines? That is one of the plans for the Oil Industry's 100th Anniversary. Harry A. Logan, Jr., chairman, Oil Industry Division, Oil Centennial, Inc., said the messages attached to pipeline "go-devils" will be directed to Titusville, Pennsylvania. Other commemorative moves will be sealing of a time capsule to be reopened in the year 2000; issuance of a special stamp by the Post Office; unveiling of a monument; a panel discussion by the industry's great; and an address on the next 100 years in oil.

Depletion Problem Comes Down Stage

Senators Williams, Douglas, and Proxmire will have an opportunity to fog up the depletion provision for oil and gas tax allowance. There was good reason to believe that this Congress would set aside proposed bills to reduce the percentage of depletion for more crucial legislation. Then La-Gloria Oil and Gas Company won a decision of a Federal District Court that the company was entitled to apply the depletion provision to its income from the sale of liquid hydrocarbons extracted from natural gas. The Treasury Department asked the House Ways and Means Committee to consider a revision of the law. The Treasury fears claims for depletion could be spread to such things as refined petroleum products instead of limited to natural gas and crude oil in the vicinity of the well.

Shell Makes Natural-Type Rubber

A subsidiary of Shell Oil (Shell Chemical Corporation) and U. S. Rubber have begun commercial production of polyisoprene rubber, which is labeled "the man-made duplicate of tree-grown rubber." Other large rubber companies have been able to produce this synthesis but have not manufactured the polyisoprene commercially in competition with natural rubber. Initial price of the Shell rubber is 30 cents a pound at Torrance, California. This is approximately the same price as for better grades of natural rubber. The product is already being used in making truck tires and is considered significant from a military standpoint.

Meetings

Apr. 15-17—National Petroleum Assn., semi-annual meeting, Hotel Cleveland, Cleveland, O.

Apr. 16-17—Rocky Mountain Oil & Gas Association, midyear meeting, Gladstone Hotel, Casper, Wyo.

Apr. 18-22—PESA, 24th annual meeting, Boca Raton Hotel and Club, Boca Raton, Fla.

Apr. 19-23—ASME, oil and gas power conference & exhibit, Shamrock-Hilton Hotel, Houston, Tex.

Apr. 22-24—API Division of Production, mid-continent district meeting, Herring Hotel, Amarillo, Tex.

Apr. 22-24—NGAA, 38th annual convention, Baker & Adolphus hotels, Dallas, Tex.

Apr. 23-24—West Texas Oil Lifting Short Course, Texas Technological College, Lubbock, Tex.

Apr. 24—Society of Petroleum Engineers of AIME, Gulf Coast Drilling and production practices meeting, Lafayette, La.

Apr. 26-28—Texas Independent Producers & Royalty Owners Assn., 13th annual meeting, Baker Hotel, Dallas, Tex.

Apr. 27-30—Physical Chemistry of Process Metallurgy, international symposium sponsored by AIME, Pittsburgh, Pa.

Apr. 29-30—WPRA, southwest regional technical-industrial relations meeting, Hotel Paso del Norte, El Paso, Tex.

Apr. 30-May 1—API Division of Production, Pacific Coast district meeting, Biltmore Hotel, Los Angeles, Calif.

May 3-6—LPGA, annual meeting, Conrad Hilton Hotel, Chicago, Ill.

May 4-5—IPAA midyear meeting, Westward Ho Hotel, Phoenix, Ariz.

May 4-6—API Division of Transportation, highway conference, Dearborn Inn, Dearborn, Mich.

May 4-7—American Geophysical Union, annual meeting, Washington, D. C.

May 4-8—API Safety & Fire Protection Committees, 12th midyear meeting, Rice Hotel, Houston, Texas.

May 5-6—AIME, North Texas section, third biennial secondary recovery symposium, Wichita Falls, Tex.

May 6-8—API Division of Production, Rocky Mountain district meeting, Gladstone, Henning and Townsend hotels, Casper, Wyo.

May 7-8—Society of Petroleum Engineers of AIME, Permian Basin oil recovery conference, Midland, Texas.

May 13-15—API Division of Transportation, annual pipeline conference, Penn-Sheraton Hotel, Pittsburgh, Pa.

May 14-23—International Petroleum Exposition, Tulsa, Okla.

May 17—ASTM, committee E-14 on mass spectrometry, Statler Hilton Hotel, Los Angeles, Calif.

May 18-20—Instrument Society of America, 1959 fifth annual symposium, Shamrock-Hilton Hotel, Houston, Tex.

May 27-29—Gas Technology Short Course, Texas College of Arts and Industries, Kingsville, Tex.

May 27-30—API Division of Refining, mid-year meeting, Statler Hotel, New York City, N. Y.

May 31-June 6—Fifth World Petroleum Congress, Coliseum, New York City, N. Y.

June 1-5—Fifth World Petroleum Congress Exposition, The Coliseum, New York City, N. Y.

June 2-4—Appalachian Underground Corrosion Short Course, University of West Virginia, Morgantown, W. Va.

Good Wells Make Good News

A Monthly Report on Wells That Are Now Worth More

April, 1959

In each of these frac jobs by Dowell, the treatment was especially designed for unusual well conditions. In each case, results were remarkably successful.

- **Sweetwater County, Wyoming** (Old Oil Well) The pay was an open hole section of the Tensleep sand from 5267 to 5575 feet. Production had dropped from 285 bopd to 110 bopd. Operator ordered Petrojel*, and Dowell injected 30,000 gallons gelled crude and 30,000 pounds sand. 1025 gallons of the temporary plugging agent used in Fixafrac* were injected at mid-treatment. During fracturing, pressures ranged up to 4400 psi and injection rates up to 20 bpm. After treatment, production leveled off at 270 bopd. The entire cost of treatment, including cost of running three-inch tubing, was paid out in slightly over one month.

- **Northeast British Columbia, Canada** (New Oil Well) Perforations into the Triassic sandy lime were from 4251 to 4272 feet. In spite of 95 per cent acid solubility, acid treatments in this formation had failed because spent acid would not come back. Fracturing was difficult because the crude oil had one of the worst emulsifying characteristics of any oil ever tested. Dowell tests indicated that satisfactory results might be expected if a demulsifying agent and F.L.A.* (Fluid Loss Additive) were used. The operator ordered Sandfrac*. Dowell injected 20,000 gallons modified lease crude with 20,000 pounds sand down casing at 15 bpm. Well had been producing 65 bopd. After treatment, production was 115 bopd. Payout was only two months in a field where payouts were notoriously slow.

- **Ochiltree County, Texas Panhandle** (New Oil Well) Casing perforations into the upper Morrow sand were from 7510 to 7522 feet. Dowell tests on samples of the formation and produced fluid indicated use of BDA* (Breakdown Acid) and Sandfrac. 750 gallons BDA were injected to break down formation and remove drilling mud. After clean-up, well made 5 boph on test. Then another 500 gallons BDA were injected as a spearhead. This was followed by 480 barrels lease crude and 29,000 pounds sand. Injection rate was 38.2 bpm with pressures ranging from 2250 to 2800 psi. After the well was cleaned up, it tested 394 bopd.

- **Seminole County, Oklahoma** (New Oil Well) This well was completed through perforations into the Earlsboro sand from 3294 to 3332 feet. Operator wanted a low cost fracturing job so he ordered Sandfrac. Dowell injected 4000 gallons refined oil and 8000 pounds of sand. Fifty ball sealers were injected during treatment to improve fracture pattern. Injection was down tubing at 5 bpm and 2000 psi. This well originally tested 1½ bopd. After clean-up, it tested 150 bopd through a ¼-inch choke.

Whether your stimulation problem is unusual or routine, call your Dowell representative. He can help you select a treatment designed especially for your well. For detailed information or prompt service, call the Dowell engineer in your area. In Canada, call Dowell of Canada, Ltd.; in Venezuela, United Oilwell Service. Dowell, Tulsa 1, Oklahoma.

*Dowell Trademark

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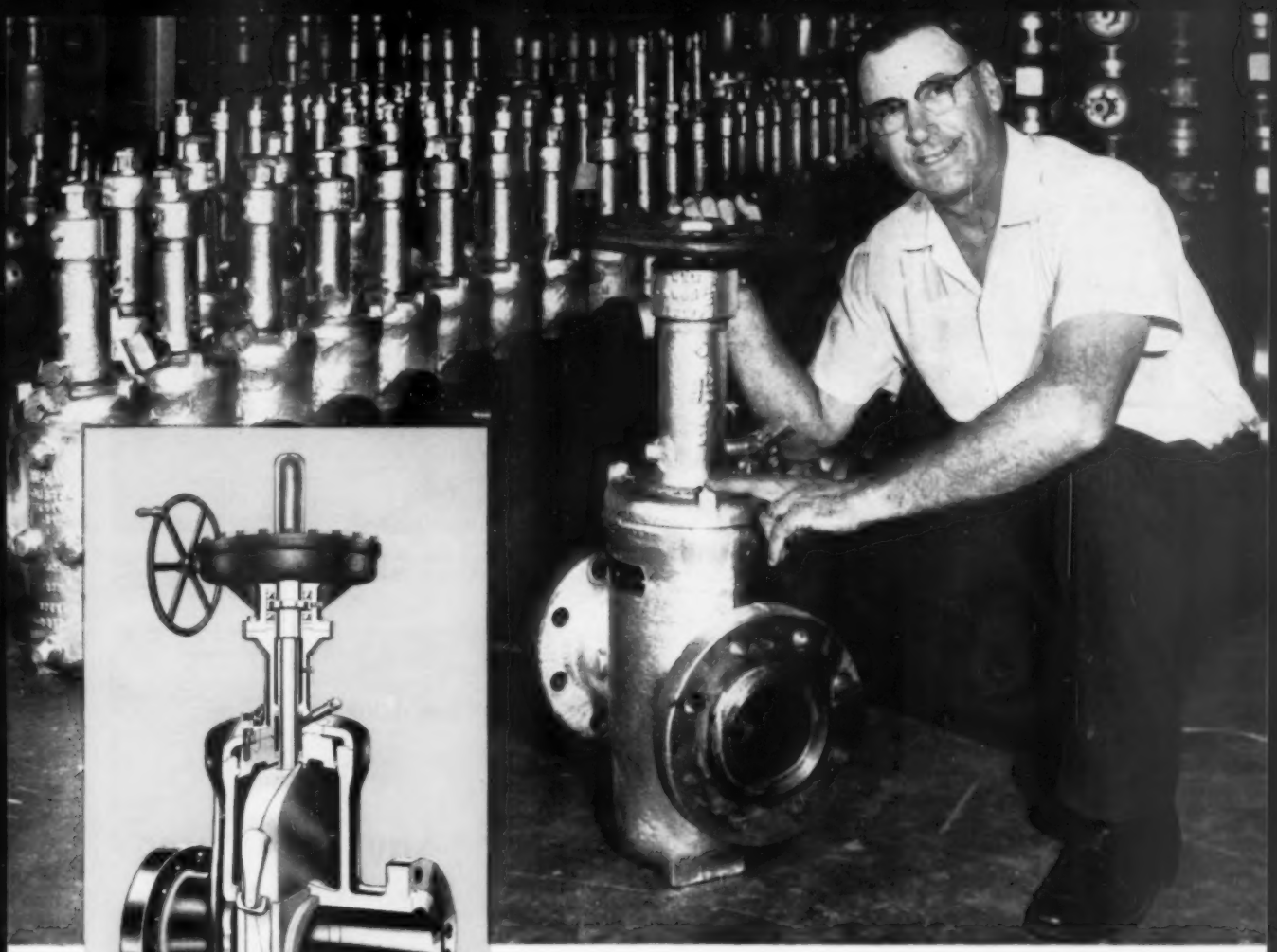

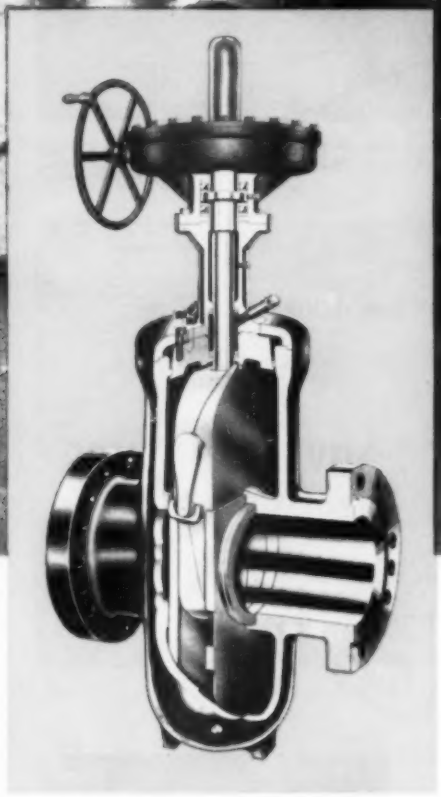

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On Hand

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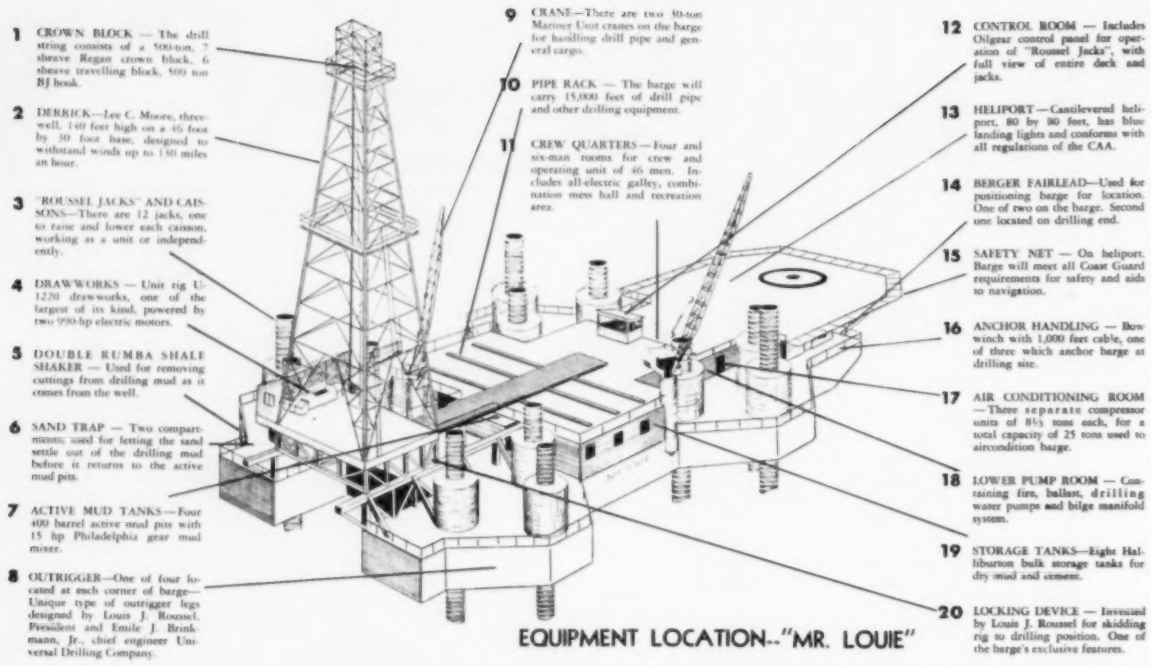

1 CROWN BLOCK — The drill string consists of a 500-ton, 7 sheave Regan crown block, 6 sheave travelling block, 500 ton BJ hook.
2 DERRICK—Lee C. Moore, three-well, 140 feet high on a 46 foot by 50 foot base, designed to withstand winds up to 150 miles an hour.
3 "ROUSSEL JACKS" AND CAISSONS—There are 12 jacks, one to raise and lower each caisson, working as a unit or independently.
4 DRAWWORKS — Unit rig U-1220 drawworks, one of the largest of its kind, powered by two 900-hp electric motors.
5 DOUBLE RUMBA SHALE SHAKER — Used for removing cuttings from drilling mud as it comes from the well.
6 SAND TRAP — Two compartments, used for letting the sand settle out of the drilling mud before it returns to the active mud pits.
7 ACTIVE MUD TANKS—Four 400 barrel active mud pits with 15 hp Philadelphia gear mud mixer.
8 OUTRIGGER—One of four located at each corner of barge—Unique type of outrigger legs designed by Louis J. Roussel, President and Emile J. Brinkmann, Jr., chief engineer Universal Drilling Company.
9 CRANE—There are two 80-ton Marine Unit cranes on the barge for handling drill pipe and general cargo.
10 PIPE RACK — The barge will carry 15,000 feet of drill pipe and other drilling equipment.
11 CREW QUARTERS—Four and six-man rooms for crew and operating unit of 46 men. Includes all-electric galley, combination mess hall and recreation area.
12 CONTROL ROOM — Includes Oilgear control panel for operation of "Roussel Jacks", with full view of entire deck and jacks.
13 HELIPORT—Cantilevered heliport, 80 by 80 feet, has blue landing lights and conforms with all regulations of the CAA.
14 BERGER FAIRLEAD—Used for positioning barge for location. One of two on the barge. Second one located on drilling end.
15 SAFETY NET — On heliport. Barge will meet all Coast Guard requirements for safety and aids to navigation.
16 ANCHOR HANDLING — Bow winch with 1,000 feet cable, one of three which anchor barge at drilling site.
17 AIR CONDITIONING ROOM —Three separate compressor units of 8½ tons each, for a total capacity of 25 tons used to aircondition barge.
18 LOWER PUMP ROOM — Containing fire, ballast, drilling water pumps and bilge manifold system.
19 STORAGE TANKS—Eight Halliburton bulk storage tanks for dry mud and cement.
20 LOCKING DEVICE — Invented by Louis J. Roussel for skidding rig to drilling position. One of the barge's exclusive features.

EQUIPMENT LOCATION--"MR. LOUIE"

"Mr. Louie" Combines Safety, Time-Saving Devices

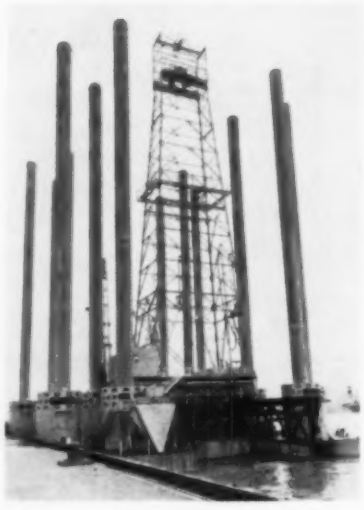
New Deep drilling barge has some unique features along with innovations based on present successful equipment and design

BEFORE he got down to the business of building a deep drilling barge, Louis J. Roussel said he visited just about every barge operating in the Gulf. He saw the designs of barges and equipment and placement that worked and those that the owners thought could be improved.

So the Universal Drilling Company's "*Mr. Louie*" has the features that President Roussel found good in other barges and developed for his own. He also designed some items new to the offshore drilling equipment that his experience said were needed.

The new drilling barge is big – 133 ft by 249 ft — and cost to build and equip it was $4.5 million. It was built by the Port Houston Iron Works at Houston and towed to its home port at New Orleans for completion. Construction began in August 1957.

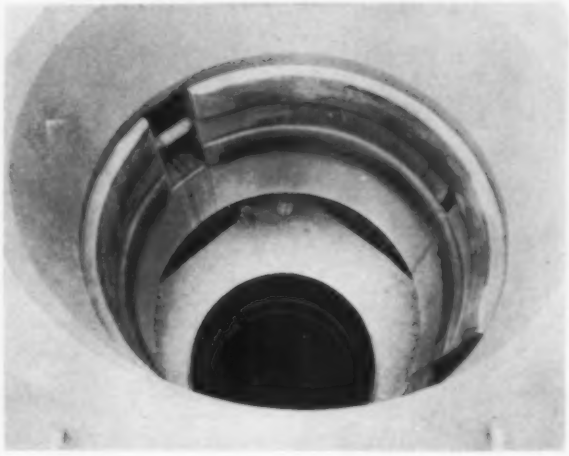
Roussel, a veteran oil producer, is understandably proud of several pieces of equipment which he invented. One



The 12 caissons are up in position to be towed. Note rings of steel around legs to fit Roussel jacks.

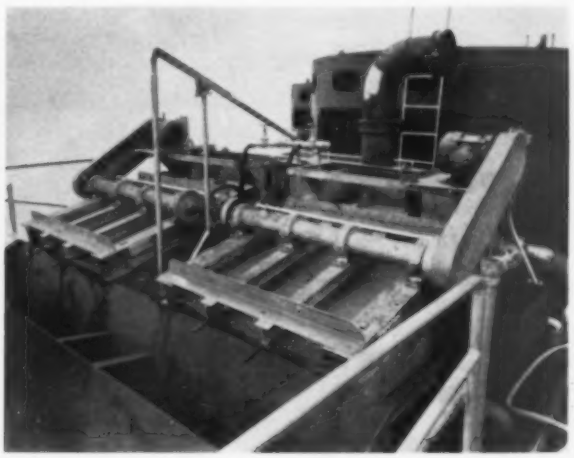
Roussel shows his locking device for skidding rig to drilling position. Device is moved by hydraulic cylinder.

Emile J. Brinkmann, Jr., chief engineer of Universal Drilling Company, tests controls of the Roussel jacks as Louis J. Roussel, president of the company, looks on.



Hydraulic jack taken before caisson was installed. Fixed locking rings are on top, while movable part, connected to four hydraulic rams, is shown below.

One of four 400-bbl active mud pits with 15 hp gear and mixer.



Double rumba shale shaker on Universal barge.

is a new type of positive-acting, double-locking hydraulic jack designed to provide maximum safety and stability while raising and lowering the drilling platform. There are 12 jacks, one to raise and lower each leg or caisson, working as a unit or independently. Each jack cost approximately $60,000.

The Roussel jacks are unique in that each six-foot diameter leg is ringed with 8-in. wide by 1⅜-in. thick bands, welded on 18-in. centers onto which positive locking jaws fit. These grip the entire circumference of the leg during each step of the lifting or lowering maneuver.

Control of the Roussel jacks is handled through an oilgear control panel in a towering control room located amidship of the barge with a full view of the entire deck operation and all jacks.

Another new device of Roussel's not previously used on an offshore drilling barge is a locking mechanism for skidding the derrick into drilling position.

The derrick substructure is skid mounted on special tracks and powered by hydraulic jacks that can move the derrick into three different locations, making possible the drilling of nine wells without moving the barge. Designed to drill to 20,000 ft or better, the barge carries 140-ft derrick.

The four outrigger wings that extend from the barge and provide platforms for four caissons is said to result in lightening the overall weight and increase the stability of the barge. This feature was developed by Roussel and Emile J. Brinkmann, Jr., chief engineer of Universal Drilling.

The outrigger legs give the barge a much wider base at sea bottom, enabling it to work in deeper water and rougher weather than the usual barge of near comparable size. The barge will be able to operate in waters up to 120 ft with 40-ft clearance above waves.

Handsome quarters are provided for the crew and operating unit of 46 men in four and six-man rooms with large wooden bunks and lockers for each man.

There is a combination mess hall and wardroom type recreation area equipped with television and a library. The entire quarters are air conditioned with three separate compressor units.

"Mr. Louie" has ship-to-shore radio, AM-FM, and also a mobilephone.

Operationally, *"Mr. Louie"* is towed to its drilling location by tugs with its 12 legs partially lowered for maximum balance and locked in the jack. On arrival at the drilling site the legs are lowered to the ocean floor until the full weight of the unit is evenly supported; then the platform is jacked until it climbs its 12 caissons to a point 40 ft above the water and the unit is ready for drilling.

From recent increase in state lease auctions offshore operations are looking up. The fine line of barges — of which *"Mr. Louie"* is the latest — has contributed substantially to successful drilling in the Gulf. ★ ★ ★

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For details on *the complete line* of lubricated plug valves for refinery and gasoline plant services, write: Rockwell Manufacturing Company, Pittsburgh 8, Pa. Canadian valve licensee: Peacock Brothers Limited.

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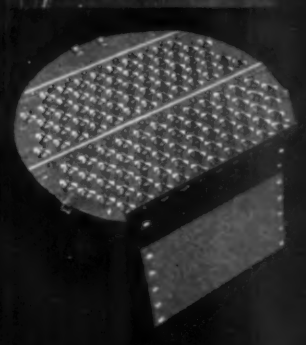

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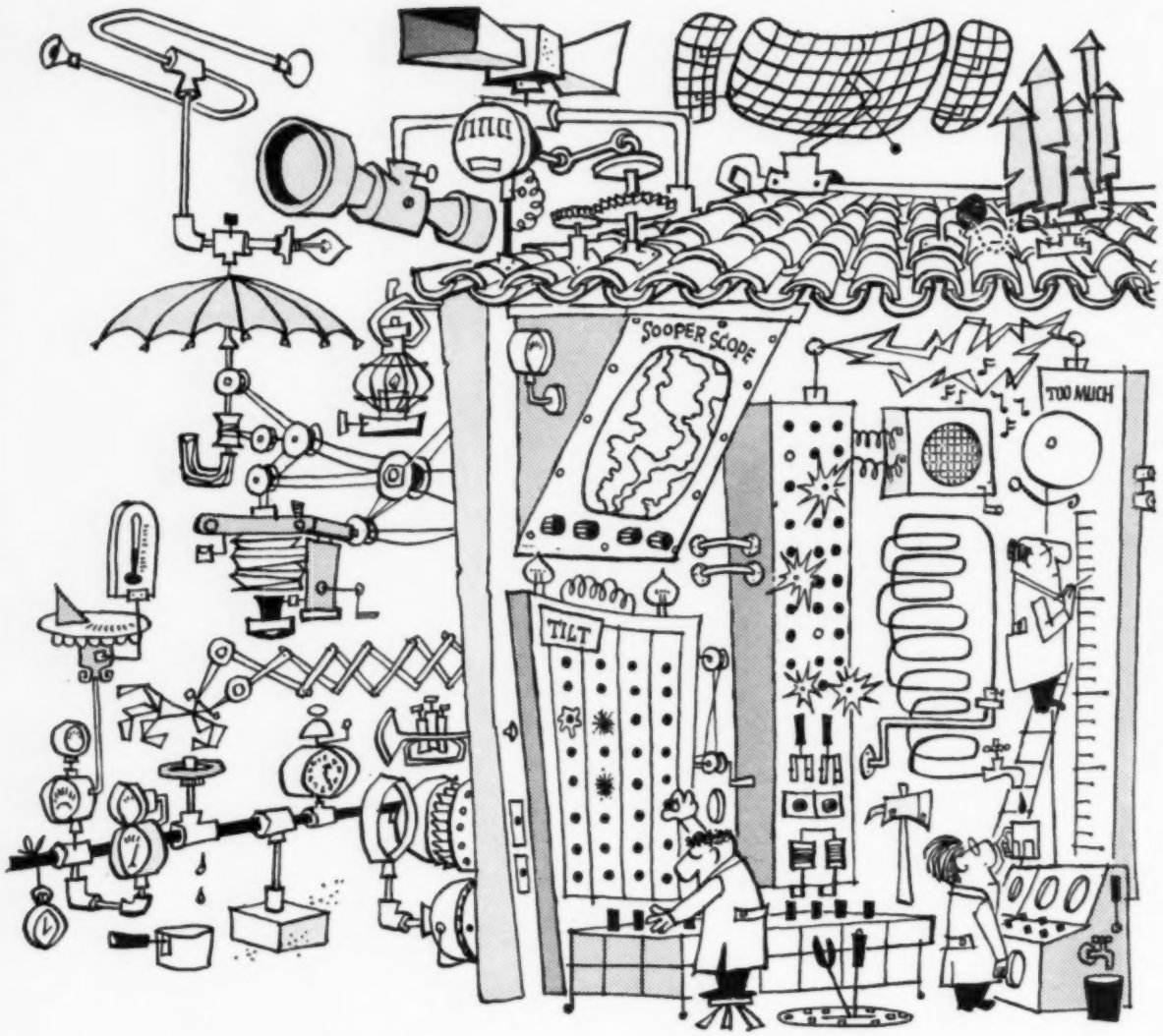

How much control does your pipeline need?

If you have some imagination, like our artist, you can go hog-wild in working out a pipeline control system. If you really wanted it, Union Switch & Signal could even give you a digital read-out of your mother-in-law's blood pressure a thousand miles away.

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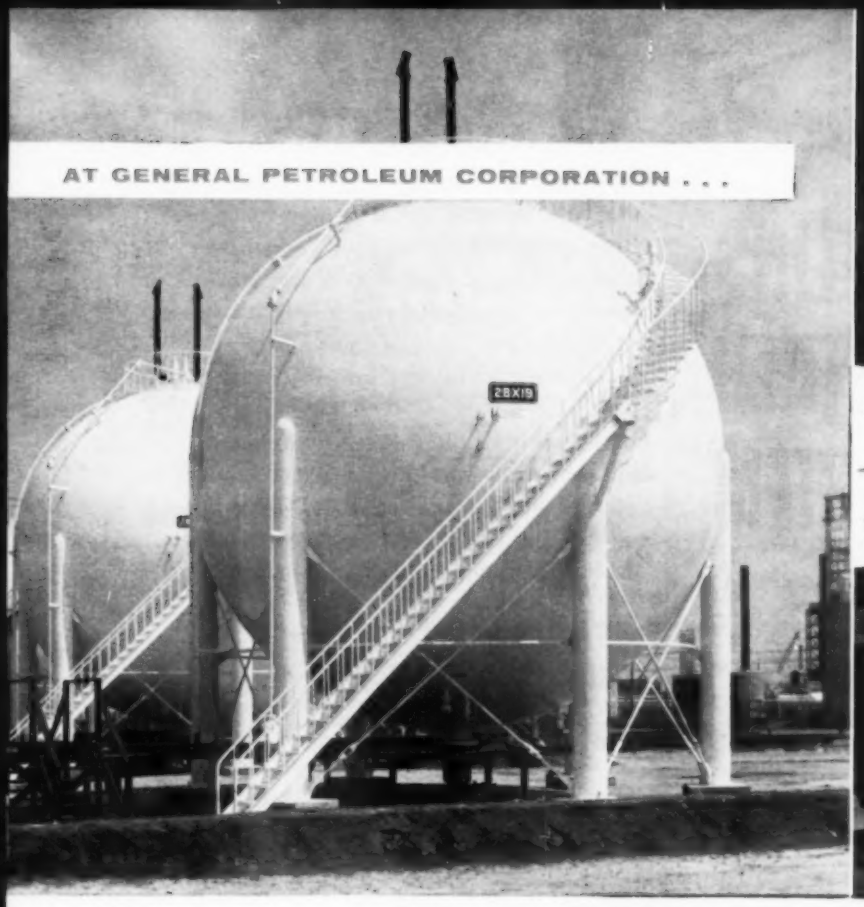

Portable X-ray unit used by CB&I to inspect welded seams on field erected work.

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Field X-ray and stress relieving facilities are typical of the many highly specialized metallurgical techniques and equipment which CB&I has pioneered and put to work on structures that *work* rather than merely *serve*.

Such facilities point up the many "extras" you get when you specify CB&I . . . the engineering service and attention to metallurgical details that mean a *lot* in today's complex refining operations.

Write your nearest CB&I office for the brochure: *The Evolution of the Oil Storage Tank.*

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Dear Legal Advisor:

Who Pays for Dry Holes and Red Tape From Washington?

A Doctor/Public Utility runs into a Maypole of red tape . . . "Everything ventured — nothing gained," he says . . . In this letter to his lawyer he presents his case . . . slow suicide . . .

DEAR MR. LAWYER,

As you know, I am a practicing physician by profession, but for many years I, along with numerous merchants and professional men here in our town, have been working with a geologist and on many occasions have been investing spare funds with him in the buying of oil and gas leases and in drilling wells. To date I have gone into 16 such ventures. Some of my friends here have gone into more than that.

You are among this venturesome group and I believe that you told me that, although you had participated in the drilling of several wells, you had not had any good luck yet and that all of yours were dry holes, and that you had lost everything that you had put in. Of course, all of us keep looking for the "big strike" and we keep hoping.

EDITOR'S NOTE: Our correspondent wants to remain anonymous but we can assure you (as you can assure us after you've read this) that he knows exactly what he is talking about.

Probably I have been as fortunate as anyone in the group because I have now secured an interest in some gas production in 2 of my 16 ventures and now have a gross income of about $115 a month, before deducting operating expenses and taxes.

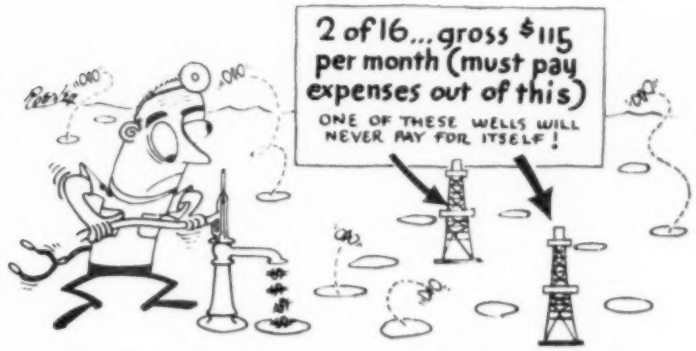
In the two productive deals we now have four natural gas wells. From what our geologist tells me, I do not have any hope for one of the two productive ventures ever paying out what we put into it, although it may pay operating expenses for a few years yet. The other productive one may possibly pay itself out during my lifetime, but it seems obvious that I can never get enough money back out of those two productive ventures to repay me for all the money that I have put into the 16 ventures.

Over the years you, as a lawyer, have been representing me and most of the others in my group in legal matters. Although your fees may have seemed high at times, I have always paid them without argument. In checking around to see how I might cut corners on expenses, I find that your annual legal fees in the last four years have totalled many times what they were before that. It appears that practically all of the additional legal work that you have done in the last four years has been on matters involving the Federal Power Commission up in Washington.

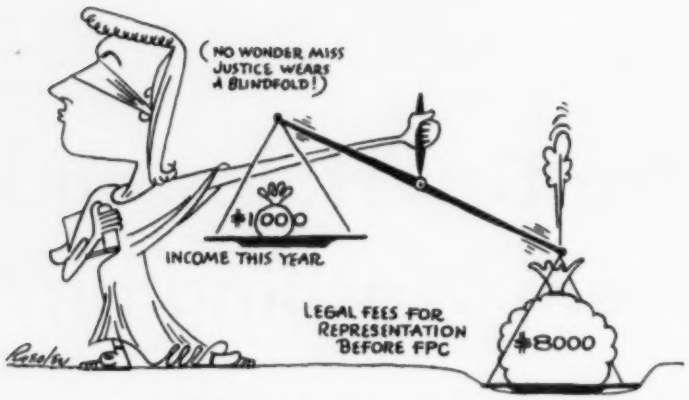
About four years ago you told me that the United States Supreme Court had rendered a decision in some case involving a sale of natural gas by Phillips Petroleum Company and that thereafter, whether I liked it or not, I was a "natural gas company," although I do not have any "company," corporation, or partnership. You also then told me that thereafter the Federal Power Commission would tell me how to run my business. I remember that I then asked you what they knew about my business, and you said that you did not know—only time would tell.

Since then you have been spending a lot of your time and my money in connection with regulation by the Federal Power Commission. It has reached the point where I believe I would rather have your legal fees than have my interest in the four gas wells. If you are interested in a trade, let me know.

Many of my friends in our group are apparently in the same fix that I am in, and we have been talking it over. In the last four years we have all been signing a lot of things that you have prepared for the Federal Power Commission and we have been receiv-



Two deals get production — can they pay for the 16 ventures I put money into? I'd say not.



Practically all additional legal work in the last four years has been on matters before the FPC in Washington, D.C. I'd trade all my gas income (minus expenses) for your legal fees on my gas property.

ing all sorts of forms, orders, etc. I have turned all of mine over to you, since I do not know anything about law, but I have tried to read all that I could find about this matter of regulation by the Federal Power Commission.

Now, I do not propose to re-discuss with you the question of whether or not the Supreme Court knew anything about my business when it decided the Phillips case, but this matter of regulation is what concerns me now. It is a certainty that I do not know anything about the business of the Federal Power Commission, and I have just about come to the conclusion that the Commission does not know anything about my business either.

My friends and I are concerned about many of these problems, not from the standpoint of your legal reasoning, but for practical and economic reasons. To put it bluntly, we do not want to continue putting money into wildcat ventures looking for the "big strike" unless we have a reasonable expectancy of being able to cash in on the "big strike" if we should ever be lucky enough to hit it. Neither do we want to continue to operate if your legal fees are going to eat up all of our income. Mind you, I am not arguing with you about the reasonableness of your fees. We are merely trying to look down the road to see where we are going.

So now, Mr. Anthony, I have some problems. There are scores of questions that I have in mind, but in this letter I will try out only a few of them on you and then take a look at your fee before I send you any more. Let's take an easy one first.

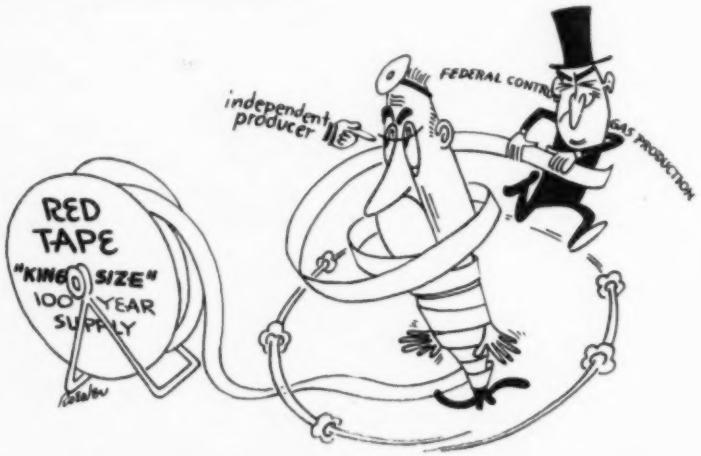
Back in December 1954, you ruined my Christmas holidays by handing me a copy of an order No. 174-B, issued by the Federal Power Commission on December 17, 1954. It was apparently a revision of a couple of earlier orders, Nos. 174 and 174-A, at which I had glanced but which I returned to you for handling. You then told me that I was an "independent producer" as defined in that order. I suppose that I am a "producer" but I am now beginning to wonder how "independent" I am. Were they just trying to kid me? If I have to hire you to go to Washington to get permission from someone up there before I can put a valve on a gas well, just how "independent" am I?

You also told me that probably the Commission was referring to me when they used the word "company" in such places as Section 154.97 of that order, but when I told you that I had neither a "company," a corporation, nor a partnership, you only mumbled.

But, I notice that throughout that Order No. 174-B, they keep *assuming* that I am rendering a "service to the public." Don't those people up there know that I am not now rendering, and never expect to render, any service to the public in the gas business? Don't they know that I am not a public utility like our local gas distributing company? I have never held myself out to the public or any portion of it as "rendering a service" and I never expect to. And, as you well know, I certainly have no exclusive franchises. Now, if they are willing to give me an exclusive franchise, for say five counties in my state, and if they are willing to guarantee me enough income to keep me in business, then perhaps we can get together and talk business. But, until then, I do not see how they can ever expect to regulate my business like that of a public utility.

For example, I notice that in Section 157.28 of that Order No. 174-B, they have entitled it "Abandonment of Service", and have purported to order that "No independent producer — shall abandon all or any portion of — any service rendered," etc., without first obtaining permission and approval from the Commission, after a hearing up there in Washington. Don't those people know that gas wells are just like human beings? They die. Some die in infancy and some live to old age. But they all die, sooner or later. To me it is just as silly to tell a gas producer that he can't abandon a gas well, without first obtaining permission from some bureaucrats in Washington, as it would be for me, as a doctor, to tell one of my patients that he can't die without first getting permission from the Public Health Service in Washington.

But perhaps I have misunderstood them. Do they mean that they want to keep me in business? If so, then where is my protection? How can they guar-



Who needs a Milltown more than an independent producer bound up in government red tape. You tell me — I'll prescribe for him free.

antee that I will ever get my expenses back?

It appears to me as if that entire Order No. 174-B, as well as a lot of other orders that I have seen coming out of the Federal Power Commission, are based on a false premise. They all *assume* that I am a public utility rendering a service to the public. Of course, you and I know that I am no more of a public utility than is the cotton farmer who may haul 10 bales of cotton into town one year and, because of drouth or flood, only one bale, or perhaps none, the next year. I am no more of a public utility than is the bearded prospector with his burro and bedroll in the mountains. The cotton farmer merely has a few bales of cotton to sell, if he is lucky. The prospector has a sack of gold nuggets to sell, if he is lucky. I have a batch of gas to sell, if I am lucky. But neither the cotton farmer, nor the prospector, nor I can assure the public a supply of cotton, gold, or gas; we do not have any exclusive franchises; none of us holds himself out to serve the public; and no one assures any of us enough income to stay in business. Don't those people up there in Washington realize that if they want to regulate me like a public utility, they are going to have to give me also the guarantees, exclusive franchises, and assurances which a public utility enjoys?

Now, Mr. Lawyer, are they going to fine me $5000 and put me in prison for two years if I allow a gas well to die without permission from them? If so, then how long will it be before I'm fined $5000 and put in prison for two years for allowing one of my patients to die without getting a permit from the Public Health Service in Washington, after a notice and hearing?

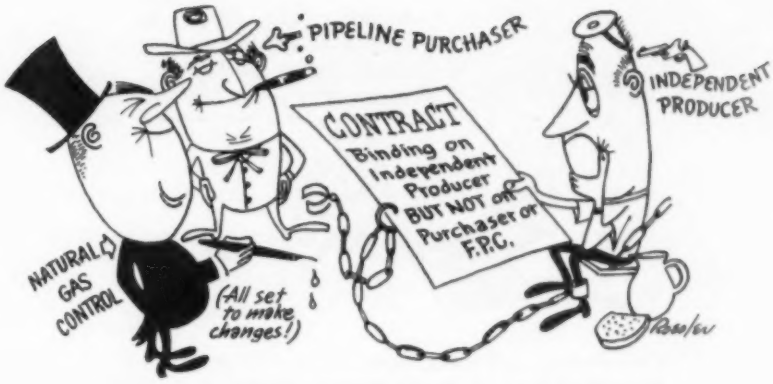
Now let's talk about this "rate" business that I've been reading about and which you have been telling me about. You tell me that up there in Washington they don't think that I've sold my gas for a "price". Oh, no. They think that I'm perpetually serving the public at a "rate." Well, if you tell that cotton farmer that he can't sell his 10 bales of cotton without first hiring you to go to Washington and get a certificate of public convenience and necessity, after a hearing, and if you tell him that he can't thereafter sell less than 10 bales a year forever without hiring you again to go to Washington and get another permit from the bureaucrats, after a hearing, and if you tell him that he is not selling his cotton for a price but is serving the public at an annual "rate", do you know how far the tobacco juice will fly?

Don't those people up there know that when I've sold my batch of gas I don't have any more gas left and that I may never have any more, and that I surely will never have any more if I'm not willing to take any more gambles on the "big strike"? But you tell me that they think that it was their gas in the first place and that all I'm doing is just working for them, delivering their gas to them, and serving the public. Well, if that is the way they feel about it, then can't we work it out someway whereby they will come down here into my state and assume all the losses in all the losing gambles on the "big strike"? That should work out pretty good for you and others in our group because you've never been in on a productive venture yet. Overall, that would work out fine for me too.

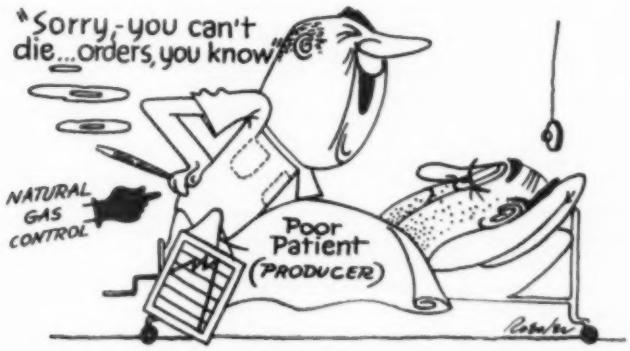
You have also told me that, when I made my two contracts to sell my interest in the gas from my two productive ventures, those contracts are binding on me but not on the purchasing pipeline company and that the Federal Power Commission can change them almost anytime they want to. Of course you drew up those two contracts before I signed them, but I'll not argue about that either. But why should I ever enter into another contract if it doesn't mean anything and if it isn't binding on anyone but me and if those people up there in Washington can change it at will?

When I signed up on one of those contracts, I had a pretty good idea, from what my geologist told me, that I didn't have enough gas there to ever pay me out on what I had put into that venture, but I got the best price I could get, figuring that it would do a little better than pay operating expenses for a while. The pipeline company man told me that they couldn't afford to pay as much for the gas for the first five years as they could for the next five years because they had to amortize the line into my well. But then later you told me that the Federal Power Commission regarded that one cent increase at the end of the first five years as a "change in rate", and that they said that I couldn't collect it unless I went to Washington with you and proved to them, in a hearing, that the "change in rate" was just and reasonable. Then I asked you what is "just and reasonable" and you just mumbled again.

Then I asked you if you knew what



How can a contract be binding on the producer but not on the pipeline purchaser or the FPC? That's a decree — not a contract — and I'm saddled with it.



You can't let a gas well die without permission from Washington, you know. Must a doctor have to get permission from the Federal Public Health Service before a patient can die?

Who can be a doctor and a public utility? Would alternate days do? Where can you find some authority to go with all that load of responsibility?

the Federal Power Commission thought just and reasonable meant, and you said that they didn't know either. I believe you told me that they had in one instance entered an order in which they decreed that it was necessary for them to establish standards for determining what is just and reasonable, but that they later changed their minds. When producers did their best to present evidence, the Commission merely dismissed the cases and, in effect, told the producers that they didn't know how it should be done, but that, however it is, the producers didn't do it. Isn't that playing the game pretty loose?

And that is apparently what they said to me in my case. And, incidentally, I have added up your fees and our expenses to Washington in connection with those hearings in my case. They total up to far more than that one cent increase would ever have amounted to, and I still don't have the penny. And, I believe I forgot to tell you that when you and I were in Washington some one showed me some figures and statistics one evening which he said proved conclusively that one of the eastern distributing companies, which uses my gas, makes more net profit off of my gas than I collect for it gross at the well. I wish you would check into that. I don't understand why that is. Maybe I'm in the wrong business. Perhaps I should get into the distributing business. And, incidentally, I noticed that when we were in that hearing in Washington, the pipeline people who had contracted to buy my gas were also in there telling the Federal Power Commission that I am not entitled to the price which the pipeline contracted to pay me.

Then you also told me that later you advised one of our group that he ought to put in some type of cost evidence when his hearing came up. And you said that, when you produced evidence of his share of the costs of a dry hole which we had earlier drilled on our producing lease, some attorney for the Federal Power Commission argued that those costs should not be included because the well was dry and was not "used or useful" for the public benefit.

Of course, you and I know that if we can't get any benefit from the "big strike" if we are lucky enough to hit it, we're not going to gamble our money. And you and I know that if we can't get what the gas is worth, and if we can't get enough to pay for all the dry holes as well as the producers, we're not going to stay in the business long.

Since I've never made any profit out of my gas producing business, I've never paid any income taxes on it, but I do pay some income taxes on my medical profession. I wish you would tell me why it is that the government should use my tax money to hire lawyers to fight me and to tell me that I'm not entitled to the price at which I've sold my gas because my many dry holes are not "used or useful" for the benefit of the public. Please answer that one so that I can understand it.

Now, Mr. Lawyer, I have lots more questions to ask you but I'll reserve them until later, after I've seen your bill for answering these. I would appreciate your early reply.

Yours very truly,
Dr. William Jones
A Natural Gas Company

Natural Gas Producers Lose Hope For Freedom From Federal Control

No natural gas bill is planned for the present congress. No effort will be made to remove independent natural gas producers from Federal Power Commission regulation.

In his speech before Dallas Desk and Derrick Club in March, Jake L. Hamon, former American Petroleum Institute chairman, said there would be no attempt to pass legislation this year that he knew of.

Congressman Oren Harris (D-Ark.), Chairman of House Commerce Committee and a proponent of some action to release independent gas producers, said that no bill would come out of his committee.

The frustration of natural gas producers is well illustrated in this letter (beginning on Page E-1) from a doctor who invests his savings in oil and gas ventures. His affairs are bogged down in legal matters and regulation red tape.

Rep. Harris has had considerable frustration, too, because of his bill that would end present utility-type regulation but keep some price control. He has run into lack of enthusiasm in the industry, he says, and disagreement about provisions of the proposed legislation.

It is probable that time lapse between beginning of FPC control (instated with Supreme Court decision in Phillips case) and distinct results of that control will be too extended to provide a clear case for either side.

Gas prices are going up but they could have risen without controls. Gas is still underpriced compared with oil. There is some reason to believe that complete freedom from regulation right now would bring a drop in prices. Some gas reserves — the amount would be hard to estimate — are shut in because of costly red tape and legal fees.

The longer the present situation continues, the less interested will be the independent operator and his financiers (like the doctor). Expensive risks that outweigh possible returns are seldom taken. Exploration for gas reserves may decline rapidly.

On the other side, the trend toward deep drilling[1] continues and deep wells find more gas-condensate reserves than any other kind. Those who seek reserves cannot specify gas or oil.

Politically there will be no answer until the industry is united on a program and can present detailed consequences of the Act to prove its case for freedom from controls.

[1] See "More Deep Holes at Less Cost," *The Petroleum Engineer*, March 1959, Page B-19.

Management Training

A program of four weeks is given annually at Pennsylvania State University . . .
Course covers broad areas of management . . .

Earl P. Strong

The author, Dr. Earl P. Strong, directs management program at PSU.

EXECUTIVE MANAGEMENT program at The Pennsylvania State University offers to top management men the opportunity to develop a better understanding of the influence of economic, political, and social forces on management decisions; to delve into policy problems from an organizational rather than from a departmental viewpoint, and to acquire understanding of tools, techniques, and attitudes necessary to implement executive decision-making.

Method. The program is designed to provide an integrated study of essential areas of management, rather than a series of specialized courses. The small group conferences, which characterize the program, facilitate this approach. The program begins with a study of the factors, both external and internal, which affect the determination of company policy, then progresses logically into the problems of internal management, and ends with the development of action recommendations.

Instruction is provided by nationally recognized authorities drawn from other universities, business, and Pennsylvania State faculty. Classes meet Monday through Saturday noon.

Teaching methods are designed to assure active participation by all members. A discussion leader, expert in his field, presents his topic and then guides the discussion of issues under his topic.

Cases are used to focus these issues and to present actual business situations for solution by small conference groups. Small conference groups of 10 men each, working under the rotating leadership of one of their own members as chairman, and one acting as secretary, provide an effective means for individual participation in discussion and for practice in oral expression and conference leadership.

Outside guest speakers, including scholars, businessmen, and government officials, will present afternoon talks related to the day's discussion and conduct question-and-answer sessions concerning them. Some evenings are devoted to seminars on topics of special interest to the group.

Areas of study. Scope of the program can be gained from the following outline of the 1959 summer sessions. The program will be offered during the summer of 1959. The dates of the course are July 5 to August 1.

OUTLINE OF TOPICS

Week One

1. Top Management and Its Responsibility.
   - A. External — The Business Unit in an Economic World.
   - B. Internal — Methods and Techniques of Sound Management.
   - C. Theory of General Management.
2. Policy Formulation
   - A. Interrelationships of Finance, Production, Distribution, and Personnel Problems.
   - B. How Policies Are Formed.
   - C. Decision-Making in an Enterprise.

Week Two

3. Organization
   - A. Resource Requirement — Money, Men, and Materials.
   - B. Delegation of Responsibility with Attendant Authority.
   - C. Organization Structure.
4. Human Relations
   - A. Leadership.
   - B. Communications.
   - C. Resistance to Change.

Week Three

5. Productivity and Meeting Competition
   - A. Problem of Productivity.
   - B. Automation and Its Potential Effects.
   - C. Research as a Factor.
6. Managerial Controls
   - A. Effects of Controls.
   - B. Budgetary Controls.
   - C. Production and Sales Controls.

Week Four

7. Political, Economic, and Social Trends and Problems
   - A. Economic Growth and Stability.
   - B. Production, Distribution, and Consumption.
   - C. Government and Management.
8. Top Management Integration of Forces, Factors, and Functions
   - A. Principal Problem of Management.
   - B. Effective Methods of Integration.
9. Program of Action
   - A. Utilization in Managerial Situations.

Selection of members. Candidates for admission to the executive management program must be nominated by a responsible officer of the employing firm.

Company officers are requested to nominate men who are already serving in important executive positions and who appear to possess the abilities to advance further.

Program fees. Total cost of the four weeks' session is $1,000, including tuition, all instructional books and materials, living accommodations, and meals.

Application. Enrollment in the executive management program is limited to 40 men. Correspondence is invited from interested company officials. Write to the Director, Dr. Earl P. Strong, College of Business Administration, The Pennsylvania State University, University Park, Pennsylvania.

★ ★ ★

Dr. Strong is director, executive management program, College of Business Administration, the Pennsylvania State University, University Park, Pennsylvania.

This is what a refinery does and this is how the tank cars come up to the shed and are loaded with one product or another. The refining kit of Standard of California is for older students than the oil field kit.

PETROLEUM

From the third grade up, Standard of California provides without charge lively material to schools in its marketing area to help dispel the mysteries of petroleum operations . . . The kit program, now eight years old, has added a fascinating new one on distillation and products . . .

Ernestine Adams

Oilfield kit made up shows subsurface with trapped oil, seismic equipment, storage tanks, separator and drilling rig with basic equipment. When you have an oil field you can touch, you bring a lot of knowledge into focus.

THOUSANDS of school boys and girls know what a drilling rig looks like, how a refinery performs, and how oil is transported because Standard Oil Company of California has made it possible for them to learn more easily.

This company provides the best demonstration material on a broad scale for grade and high schools available. Its program is comprehensive and imaginative. Oilfield and refinery model kits would attract youngsters in the toy department.

The oilfield kit contains plans, materials and instructions necessary to build a model oil field. The finished model exhibits geological strata, aerial and seismographic mapping, well drilling, pumping, pipelines, and storage.

A helpful booklet on use of the drilling kit was reprinted by Standard from California Journal of Elementary Education. The "suggested sequence of experiences" is thorough and detailed.

The refinery model can be used to demonstrate basic processes in oil refining and lead the student into marketing and distribution methods.

A distillation and petroleum products kit recently introduced fascinates adults as well as pupils. The central portion shows the distillation tower in which are set plastic containers of crude oil and five basic stocks derived from crude by simple distillation. The attached flow chart illustrates further treatment of each stock and, finally, some of the finished products which may be made.

Text material, for use by teachers, is included. The distillation kit deals with the formation of molecules, and how they may be rearranged to form a number of familiar solids, liquids, and gases. A series of card panels for use by the teachers covers the experiments to be done by the class. The remarkable feature of this distillation kit is that it is simple enough to draw fourth grader attention and understanding, and basically so comprehensive that almost any adult outside the refining business is interested.

Standard of California began the kit program in 1951 and since then has provided some 20,000 kits for schools in its western marketing area.

Besides these classroom learn-by-doing projects the company has a full school program using other methods of communication to help dispel the mysteries of oil operations.

All of these materials are described in a booklet for teachers called "Free Teaching Materials and Services." Order cards are bound in the booklet and services are numbered for convenient ordering. The chart reproduced here gives an idea of how extensive this project is. Two booklets, "Story of Oil," an excellent piece, and "Oil Pictures" are available to pupils.

Models, specimens, study prints, motion pictures, filmstrips can be obtained through the school's audio-visual curriculum department or

IN EASY LESSONS

Distillation experiment with new distillation and petroleum products kit introduces the principles of molecular science to pupils in fourth to eight grades. Plastic containers in the stand up frame at right create an illusion of the refining process.

MATERIALS STANDARD OF CALIFORNIA HAS AVAILABLE TO SCHOOLS

TEACHING MATERIALS		Grades For Which Material Has Been Prepared													
		1	2	3	4	5	6	7	8	9	10	11	12	College	Teachers
MODELS															
Model Oil Field					•	•	•	•	•						
Model Oil Refinery							•	•	•	•	•	•	•		
TOURS										•	•	•	•	•	•
FILM STRIPS															
Story of Oil							•	•	•	•	•				
Highway Safety								•	•	•					
Energy											•	•	•	•	
MOTION PICTURE CATALOG	D-1						•	•	•	•	•	•	•	•	•
STANDARD SCHOOL BROADCAST					•	•	•	•	•	•					
Teacher's Manual	E-2														•
BOOKLETS															
Oil	F-1									•	•	•	•		
Story of Oil	F-2						•	•	•						
Oil Pictures	F-3				•	•	•								
Bulletin	F-4							•	•	•	•	•	•		
Annual Report	F-5									•	•	•	•	•	
World Wide Enterprise	F-7							•	•	•	•	•	•		
Basic Reading List	F-12														•
How To Create Classroom Bulletin Boards															•
CHARTS															
Land Transportation	F-23			•	•	•	•								
Water Transportation	F-24			•	•	•	•								
STUDY PRINTS															
Petroleum In Our Lives					•	•	•	•	•	•					
AMERICAN PETROLEUM INSTITUTE															
Booklets										•	•	•	•		

This chart lists teaching materials available and the grades for which they are prepared. In the booklet for teachers the chart is in two colors — one showing material to be ordered directly from Standard of California, and the other showing materials available through the school's Audio-Visual Center (models, tours, films, study prints).

through regional offices of Standard of California. All teaching materials are free.

A. J. McNay, Coordinator School and College Relations for Standard, says the company has over 1200 motion pictures on deposit with school systems in its marketing area — Arizona, California, Idaho, Nevada, Utah, Oregon, Washington, Alaska, and Hawaii.

The 16-page teachers' booklet points out that annual scholarship awards are given by the company in the same marketing area to undergraduate college students. These are called leadership awards and provide $400 scholarships. Also 84 awards of $300 each are made annually to members of 4-H Clubs and Future Farmers of America.

A Standard School Broadcast Teacher's Manual serves as a listening and correlation guide for weekly music enjoyment programs presented for schools in the western states.

You'll find of interest, too, that Standard lists in the chart its annual report under booklets for grades 9-12. That is a good place to start learning what annual reports have to say in this "people's capitalism" economy.

American Petroleum Institute booklets on the chart include: "Petroleum in Our Modern Society," "The Physics of Petroleum," "The Chemistry of Petroleum," "The Conservation of Petroleum," "The American Oil Industry — A Forty-Odd Thousand Company Enterprise," "Facts About Oil." These are all for grades 9-12.

Wesley D. Gordon, a leading educator, has helped develop Standard of California's strong school program. Coordinator McNay works under S. Z. Natcher, manager of the public relations department.

In the reorganization of API's public relations into the Committee of Public Affairs the importance of individuals and individual companies in the program has been stressed again and again. Standard's diligent effort to provide preparatory school educational aids is a prime example of the work waiting to be done. Somewhat like basic research, you can't put a direct dollar in the till as a result of a school program, but undoubtedly the project helps the company's position with their public and, even more, it creates a better atmosphere for the entire petroleum industry. ★ ★ ★

THE LARGEST ARRAY OF

ASSEMBLED UNDER ONE ROOF—

Ranging from photographs of some scientific discoveries to actual working models of others, the exhibit will give oil men a chance to learn what is new in the oil science world since the last Exposition in 1953. All phases of the vast oil industry will be covered: geology, geophysics, production, transportation, refining and petrochemicals, including a technical film theatre which will cover the entire industry in sound-color motion pictures.

See on parade—exploration, drilling, production, pipeline, refining equipment and services which make the oil available for use in hundreds of items some of which are shown.

International Petroleum Exposition

MAY 14-23 . . .

1959

TULSA, U.S.A.

Commemorating

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Dates of the IPE set in conjunction with World Petroleum Congress to be held in New York a week after the Tulsa Show

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

ONE-INDUSTRY SCIENTIFIC DISPLAYS

THE IPE HALL OF SCIENCE

The scientific and technical men who have planned this exhibit are:

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Unionization of Engineers Theme of Meeting

Begin with students, urge union leaders . . . Engineers said to be "poisoned" by idea they are part of management

LABOR AND SCIENCE in a Changing World was the theme of a conference held in Washington in early 1959 under the sponsorship of the Industrial Union Department, AFL-CIO. Conference speakers dealt with the broad aspects of the technological revolution and its effects on the labor movement, ranging from Walter Reuther's call for the creation of a Labor-Science Foundation, to Paul G. Hoffman's analysis of the effect of technological development on the nation's world-wide responsibilities.

Of primary importance to the engineering profession was the panel session of labor leaders, titled, "Meeting the Needs of Scientific and Professional Workers." Under this heading, a representative group of union leaders related their experiences and ideas on organizing white collar employees — with particular emphasis on professional engineers and scientists.

Caesar Guazzo, chairman of Salary Division of the Electrical Workers, AFL-CIO, opened the discussion with an estimate that the group involved, who are largely unorganized by the unions, numbers 2½ to 3 million people. Guazzo's basic approach to organizing such employees was to recognize that the coveted employees are different from ordinary workers in that they want or expect, in addition to increased income through collective bargaining: (1) Prestige, title and position, (2) status and recognition in their profession, (3) attainment of their goals through non-violent, non-controversial means, such as strikes, boycotts, picket lines, etc.

He contended the group involved think of themselves as professionals, but actually are "mere employees," and recommended that the AFL-CIO create an Engineer-Technical Council, similar to the Building Trades Council, to coordinate and strengthen the drive.

Russell M. Stephens, president, American Federation of Technical Engineers, declared the labor movement "has fallen flat on its face" in trying to organize engineers and scientists. He attributed the failure largely to opposition of the National Society of Professional Engineers, which, he said, has engaged in "violent anti-union propaganda." He said that NSPE gets to engineering students in college and "poisons" their minds against unions.

He held up a recent article in the student publication at Georgia Tech, in which the student-author concluded that unions were not an acceptable method for professionals to resolve their problems,[1] as a "horrible example" of NSPE's influence on the students.

The AFL-CIO leader also denounced the idea of "professional" unions and cited the recent strike of the engineers' union at RCA which had led some of its members to resign because it was not a "professional strike." Stephens added: "What in the h— is a professional strike?" He urged that unions representing engineers seek to negotiate on patent rights, advanced education on company time at company expense, attendance at professional meetings and other means to serve professional interests. He concluded that the major job for the union movement is to reach the engineering students and prove to them that trade unionism is dignified.

The only non-AFL-CIO speaker on the panel, Joseph Amann, president, Engineers and Scientists of America, said that engineers have an "infatuation" with professionalism, and may even shun overtime pay because of this "notion." Amann agreed that this attitude is developed largely in the engineering schools and the young graduates, he said, believe that unionism is not compatible with their rise in the company into managerial ranks. He said that the needs of the engineers are in areas of working conditions, grievances and compensation.

Amann said that management uses merit raises as a weapon and that the unions should get some control of merit raise systems. He also advocated the unions getting a voice in company education programs.

In what he termed "spiritual" needs of the engineer, Amann called for greater credit for their work and for their patented ideas.

The "defeatist" tone of the meeting was blasted by John J. Pastin, director, Office and Technical Department, United Steelworkers, who claimed his unit had already organized some 45,000 dues-paying members among office and technical workers. Pastin said he is "irritated with all this social psychological, statistical analysis" of white collar workers. He denounced the idea that professionals are so different from production workers that they will not accept trade union concepts of seniority and time-and-a-half for overtime.

Sylvia Gottlieb, research director, Communications Workers, AFL-CIO, closed the panel statements with a criticism of the sales techniques used by the unions. She called "obsolete" and "corny" the union literature depicting "fat cat bosses" and "evil employers" in both writing and cartoons. Such concepts are childish to professional employees, she said, and urged the unions to promote the idea that loyalty to a trade union is not incompatible with loyalty to the company.

At the close of the panel talks questions and comments were invited from the floor. Ted Silvey of the AFL-CIO staff led off with the charge that engineers and scientists are "deeply poisoned" by management, in company with the engineering schools which are "owned body and soul" by the corporations. The corporations also "own" the professional societies, he charged, and called for an investigation of the college-corporation "conspiracy."

Sanford V. Lenz of the IUE local at Arma said some unions foster the "poison" by not repudiating the idea that engineers are part of management.

L. L. Schultz, executive secretary, Association of Professional Engineering Personnel, an ESA-affiliated union, took the floor to reply to the criticism of the type of strike conducted by his group. He said the AFL-CIO "is kidding itself if it thinks it can sell engineers the same way it sold machinists." Engineers must be sold unionism in the colleges, he said. Schultz added, "I have to convince my own members we are a union." The engineer knows, deep down, that he is just another employee, the union leader said, "but he has to be sold on this." Charles Hall of the Sperry engineers' union denied that there is a "profession" of engineering.

★ ★ ★

Editor's Note: This article was distributed by National Society of Professional Engineers, Washington, D. C.

[1]Published in the *Petroleum Engineer* for March, 1959, Page E-6.

You are looking at a time machine

It sounds like science fiction: traveling across the continent in 4½ hours, going from New York to London in 6½, cutting airline schedules almost in half.

Yet these are routine for jet liners in the jet age — an era people at Standard's research laboratories have been working toward since the day seventeen years ago when we fueled the first U. S. jet flight.

Since then our scientists have worked with the armed forces to perfect fuels and special lubricants for planes that fly faster than sound, or cruise non-stop around the world. They've helped engine designers solve problems of heat and cold, in addition to aiding airlines with faster airport fueling systems.

The sum of these years of development has been to add hours to the traveler's day, days to the vacationer's week. So, in helping to harness time, as well as in putting petroleum to many other uses for you, ***the people at Standard are planning ahead to serve you better.***

STANDARD OIL COMPANY OF CALIFORNIA

How to Give Orders Effectively

Ernest W. Fair

IT'S A REAL pleasure to do things for my boss.

That's the sort of expression every executive of an oil company likes to overhear one of his staff men telling another. He's always the executive, too, who is securing maximum results from his department. His department seldom has employee problems. This executive learned early in his career that there are definite *do's* and *don'ts* in making suggestions to employees.

We've talked this over with a number of such executives. The methods they use were given freely. We've incorporated them into the following list of time tested and proved steps any other executive can use to secure the same worthwhile results in his own department.

● **Treat each as an individual.** This is the top recommendation of the experts. They point out that we cannot assume all employees are alike in their reactions to suggestions from the *boss*. Each man or woman has his or her own peculiarities.

This calls for a careful study of each employee and directing the specific suggestion to these individual traits. It takes only a moment or two, and it pays off in the assurance of positive reaction from each individual when the suggestion is made.

● **Avoid "Military Commands."** There was a day when the accepted method of passing suggestions to employees was in the manner of a top sergeant issuing his "suggestions" to the new rookie. That day is gone forever. The executive who still employs the military command system of giving suggestions to employees is usually the one with the least responsive department.

Today's effective employee handling procedures call for diplomatic treatment in every relation between the company executive and his staff. Presenting every suggestion along the same vein is required procedure if we wish maximum results at our jobs.

● **Outline it to yourself first.** Here is the suggestion that seems most difficult for the new executive to learn. Many oldtimers still have not acquired a thorough understanding of its importance.

We can hardly expect maximum results unless each suggestion is well thought out and carefully detailed. Doing so is our assurance that we have overlooked no important detail involved, that it is being presented clearly and concisely, and in such a manner that the possibility for misunderstanding by the employee is reduced to an absolute minimum.

● **Be positive — not negative.** This is an important point that is continuously emphasized by every expert in employee management. All emphasize the *Do* approach rather than the *Don't* direction.

It is always easier for an employee to go into immediate action on a suggestion when he is given the specific and detailed steps to follow and when he does not have to cope with *don'ts*.

The positive suggestion is not only always easier for an employee to follow, but direct action to implement it can be taken quicker and with surer results. In those cases where it is imperative that a suggestion be put into action immediately and without error, positive presentation is an assurance that such results will be obtained.

● **Key each suggestion to the employee reactions.** After an employee has been on a staff for a few weeks, that individual's thought processes should be known fairly well by the executive. It is important that they be understood. And, it is also important that the executive carefully study each employee's fixed reactions to suggestions from the boss. When the executive has acquired this knowledge, then he is in a position to carefully key each of his suggestions to the individual's personality. This not only makes certain that we have recognized the top qualities of that employee, but are putting them to maximum use in our department.

● **Make certain "background" is given.** Here is another big point mentioned by many successful company executives. They emphasize that one must always be certain an employee is given all of the necessary background to properly carry out each and every order given him.

One of the greatest points of resentment by employees against department heads is being given orders without details on how the assignment is to be handled. Executives too often assume that every employee already possesses such background information and that it is a waste of time to go over the ground again.

Such is not always the case and it is particularly so where the suggestion or idea embraces some new procedure or plan that has not as yet been used in the company organization. Even where the suggestion involves old procedures, such details may have been forgotten by the employee or he will have to

waste precious time in organizing them in order to carry out the suggestion he has received.

● **Make clear the reward that is to follow.** This suggestion does not mean that we should hold out a reward to every employee for carrying out the orders or suggestions he is given. Such a policy would be disastrous in any organization.

What our successful executives mean by this suggestion is that the employee should be acquainted with the results that will follow the successful completion of the suggestion. When we can see worthwhile results from the things we are about to undertake, we always enter into those tasks with a great deal more enthusiasm and interest than we do where no such goals or rewards can be seen for the extra effort needed to get the job done.

● **Be sure the "reason why" is understood.** One of the prerequisite qualities of the executive mind is to know exactly why every move is made. Too often it is assumed that the employee has the same ability. The latter is true only in the most unusual cases.

In very few instances are employees required to reason out factors involved in the things they do on their jobs. The mere fact that this is seldom required, tends to dull the employee's use of this valuable facility. We cannot expect that individual to automatically reason out every suggestion presented to him.

It takes little extra time for the executive to add brief explanations of the reasons behind the suggestion he is presenting to his staff. Doing so not only assures better reception of the idea by the employees, but also adds to their ability to carry such suggestions out satisfactorily. We all tend to do things better when we understand why the assignment has been given us.

● **If it's a correction, do it privately.** Where the suggestion involves correction or reprimand, it is always good executive diplomacy to take action privately with the individual involved. Even in cases where it is a minor matter, best employee reaction can always be assured when this procedure is followed, for no one likes to be corrected in front of others.

Each of the foregoing suggestions has been of positive help to a number of company executives. They can be applied with equal success by others. Application of the foregoing suggestions will also bring to light a number of other procedures which will be of assistance to any executive in his all important job of securing maximum reaction from the suggestions he gives as part of his job, to employees every day of the working week.

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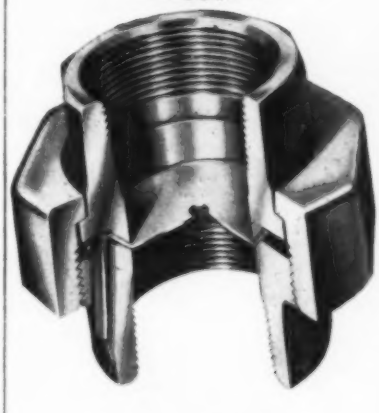

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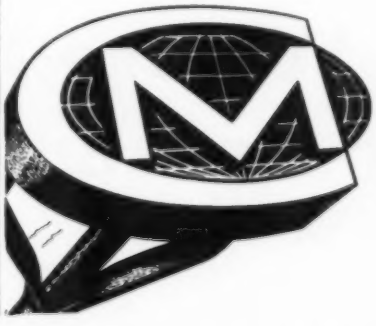

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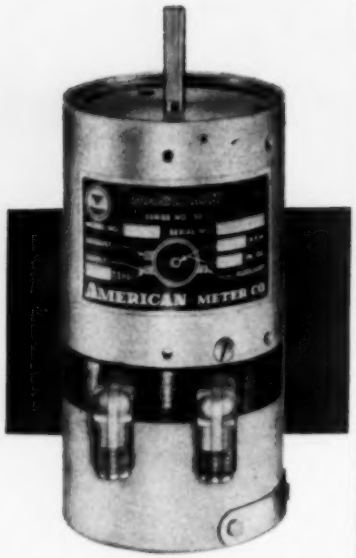

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Management Personals

Fred H. Moore, who first joined Magnolia Petroleum Company as a geologist 23 years ago, was named executive vice president and elected to its board of directors.

F. H. Moore

Now of New York City, he has been general manager of the world-wide producing operations of Socony Mobil Oil Company, Inc., for the past 14 months. In his new position, he will be responsible to J. L. Latimer, president, for all operations in Magnolia. A native of Comanche, Texas, Fred Moore received his bachelor's degree in geology from Texas Technological College in 1930, and his master's degree in geology from the University of Virginia in 1931. He spent 2 years in the graduate school of Yale University doing study in the same field.

L. E. Frensley, comptroller, was named a vice president, as was **E. J. Wacker Jr.,** now an assistant vice president. Frensley will continue as comptroller. Wacker will also have charge of employee and public relations, economics department, and the medical department of Magnolia.

Allan Shivers, former governor of Texas, was elected to the board of directors of Champlin Oil & Refining Co.

James R. Glennon was promoted to manager of employee relations research in the central employee relations department of Standard Oil Company (Indiana). He was formerly supervisor of the research section.

Fred G. Crosby was elected to the board of Sun Oil Company, Ltd. Crosby has been general sales manager.

O. N. Miller was elected to the board of Standard Oil Company of California to succeed **E. J. McClanahan.** McClanahan is retiring from the company after 47 years of service. Miller became a vice president in 1954.

C. B. Wentz is promoted to director of organization planning for Continental Oil Company. Formerly assistant general manager of Conoco's southern region, he will continue to make his headquarters in Houston.

Gen. Ernest O. Thompson, chairman of the Railroad Commission of Texas, has accepted chairmanship of the Legal Committee of the Interstate Oil Compact Commission for 1959.

Charles E. Spahr, president of The Standard Oil Company Ohio, will become chief executive officer and **Clyde T. Foster** will continue as chairman of the board and retain his responsibilities for the company's public relations.

Samuel H. Elliott, Elliott B. McConnell, Richard C. Sauer, and **Alfred E. Wolf,** vice presidents, became senior vice presidents.

Charles D. Dickey, a director and member of the executive committee of J. P. Morgan & Co., Inc., was elected to the board of The Atlantic Refining Company to fill the unexpired term of **H. W. Field** who resigned for reasons of health.

Albert Y. Woodward was appointed a vice president of Signal Oil and Gas Company. He heads Signal's government relations in Washington, D. C.

Henry J. Struth, petroleum consultant of Dallas, Texas, was retained by the American Petroleum Institute to undertake a special investigation of the entire field of statistical information now available to and on the operations of the production branch of the industry. Struth will work directly with **Fred Van Covern,** director of the API Department of Statistics, and with a subcommittee of the API's Committee on Petroleum Statistics, headed by **N. G. Dumbros,** Ohio Oil Company, Findlay, Ohio.

F. O. Griffin was appointed assistant to **W. C. Norman,** president of Colorado Oil and Gas Corporation. Griffin has been vice president and treasurer of Western Nuclear Corporation, and also was formerly manager of the tax department in the Denver and Dallas offices of Arthur Andersen and Company.

William H. Hawn, independent oil producer from Corpus Christi, Texas, was elected to the board of directors of Cosden Petroleum Corporation. He will fill the vacancy created by the recent death of Leo M. O'Neil. Hawn is currently active in the oil business as a partner in Hawn Brothers.

Dr. Leo J. O'Brien and **Dr. Melvin A. Rosenfeld** were promoted to directors of the production engineering research division and of the exploration research division, respectively of Pure Oil Company. **Ralph S. Fowler** joined the company to be in charge of the sale and acquisition of foreign crude oil. He was associated with the Department of the Interior in Washington, D. C.

DeWitt A. Forward, vice chairman and director of the First National City Bank of New York, was elected a director of Phillips Petroleum. He fills a vacancy caused by the death of J. L. Johnston.

W. C. Kernahan was appointed manager, direct advertising, in Gulf Oil Corporation's advertising and sales promotion department. He succeeds the late J. A. Burgess. Kernahan will be responsible for planning and executing all direct (industrial) advertising for Gulf. His most recent position was supervisor, direct copy and layout for the entire department.

Oliver L. Stone was named a general attorney for Shell Oil Company. He will be responsible for counselling with the company's head office exploration and production organization on their legal problems.

DEATHS

Harry D. Collier, former president and board chairman of Standard Oil Company of California, 82, died January 30, at a San Francisco hospital.

G. F. Brunston, whose retirement as vice president from Colorado Interstate Gas Company became effective March 1, died the same night from a heart attack.

H. T. Goss, 58, vice president of Arkansas Fuel Oil Corporation and Arkansas Pipeline Corporation, died unexpectedly of a heart attack at his home in Shreveport, February 10.

Albert S. Baptie, 58, of Long Beach, California, prominent in the oil industry for many years, died February 1.

J. T. Worthington, 77, pioneer in electrical dehydration of petroleum and retired general superintendent for Petreco division of Petrolite Corporation, died February 14.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

C. E. Williams, Gulf Sales Engineer, Midland, Texas, and G. W. Ramsey, Assistant Plant Superintendent, inspect force feed lubricators on one of the modern gas engines at the Goldsmith plant of El Paso Natural Gas Company.

No lubrication problems in 8 years of operation

Since 1949, twenty-seven gas engine-compressor units developing 39,985 horsepower at the Goldsmith plant of El Paso Natural Gas Company have been thriving on Gulf Security Oil. Bearing, ring and cylinder wear maintenance records have been excellent.

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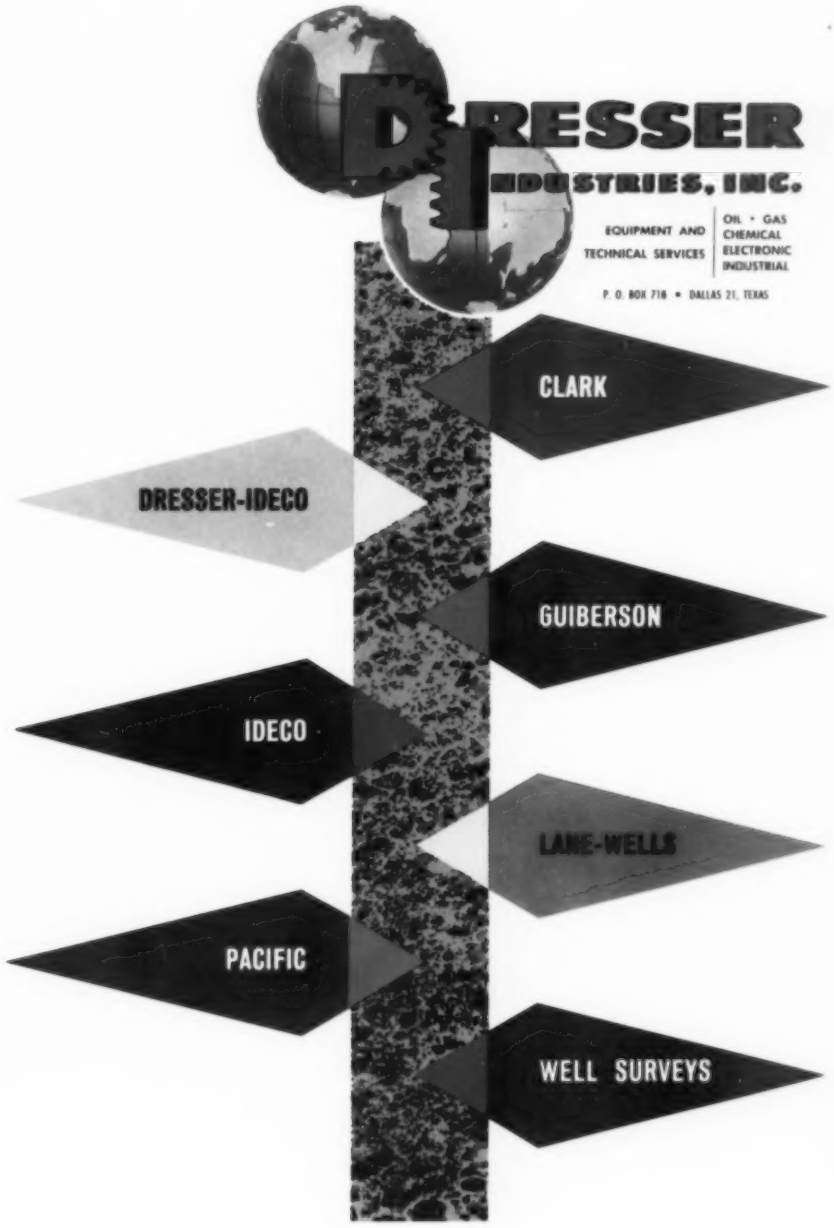

The complex task of recovering oil and gas falls to the imaginative men and technical tools of production. At left is a visual concept of a Lane-Wells Koneshot® gun perforating a cross-section of casing — one of the most modern procedures in producing oil and gas — and a sketch indicating how the gun is lowered and fired at a specific depth. Dresser companies provide production equipment and technical services which are standards of comparison the world over.

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technical oilfield services

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WELL SURVEYS
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cut disposal costs by two-thirds...

Containerize Waste as it Accumulates...

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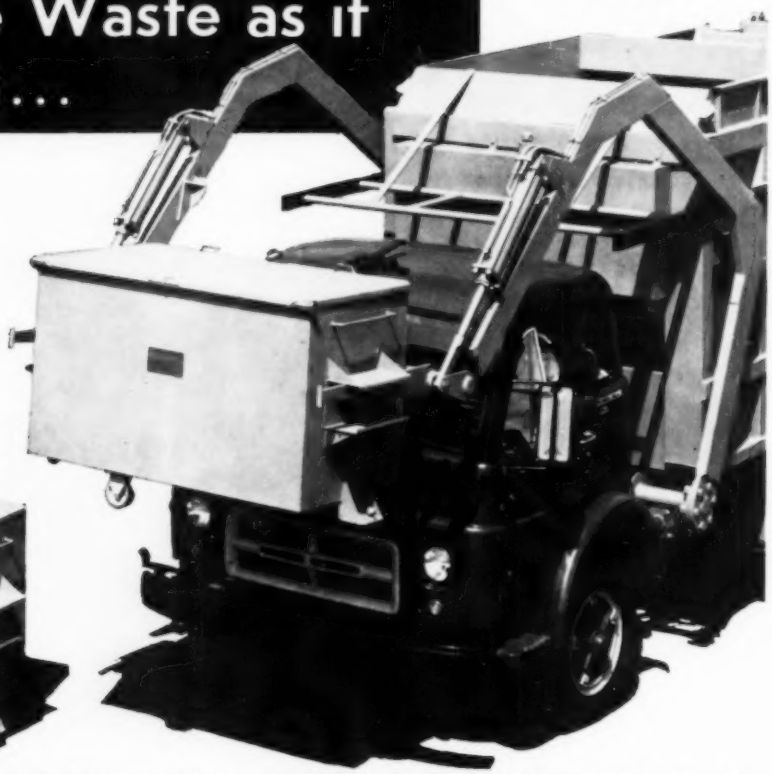

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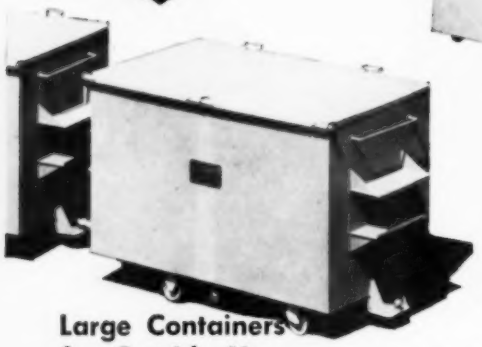

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The DEMPSTER-DUMPMASTER is economical! One man operation. It's safe! Clearance lifting arms never pass the cab windows, can't injure operator. Containers can be used indoors or outdoors, on ground, below grade or on a dock.

This system is also available on a monthly fee basis through a nearby DEMPSTER-DUMPMASTER equipped private hauler, (name furnished on request).

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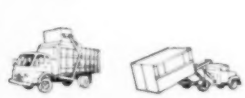

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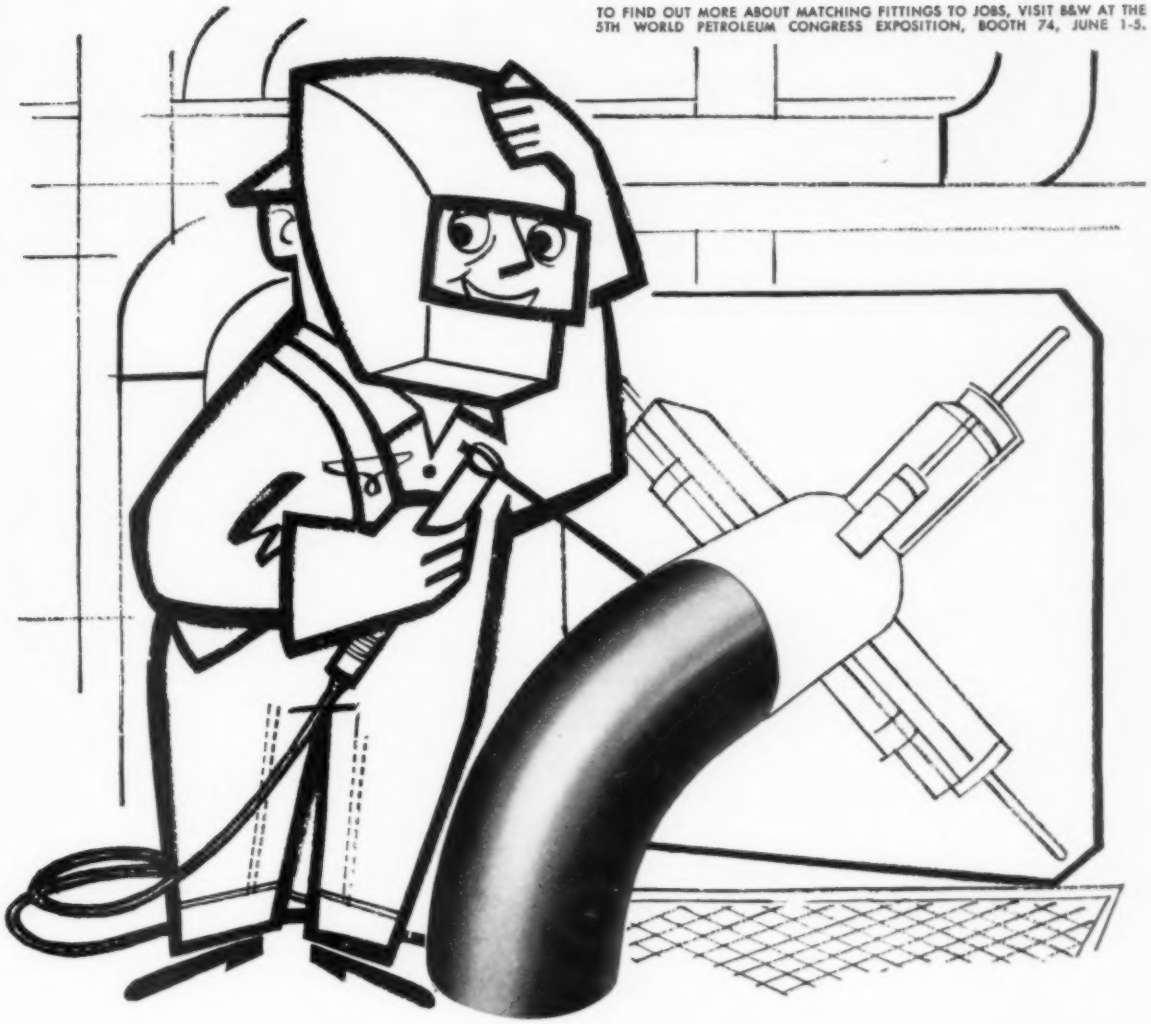

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Movable Walls Pay Off

New Socony Mobil Building has advanced ideas in flexibility — Space, power, lighting, elevator service can respond quickly to change in operation requirement

USE OF almost four miles of movable interior walls has paid off in the new mid-Manhattan Socony Mobil Building. A survey just conducted by the building administration division of the oil company's real estate department shows this is true.

Since Socony's recent move into its new home, over 20 percent of the original installation of partitions was moved in order to accommodate changing office needs. And dozens of new offices were created during this time, an indication of the flexibility possible with the steel movable walls.

Socony Mobil Building, largest office structure to go up in New York City in a quarter century, was designed with the idea of maximum flexibility — utmost adaptability to changing tenant needs — consistent with the maintenance of a pleasant, work-conducive atmosphere.

J. Gordon Carr, Socony Mobil's interior architect for its space in the 42-story building, which was formally opened in the fall of 1956, emphasized that the company's office layout required unusual flexibility.

"Socony Mobil's business," he said, "has many facets and the internal transfer of personnel and the development of new programs involve constant office changes. Flexibility to make these changes is a vital need."

One important factor contributing to this office flexibility is the use of movable steel partitions for office walls. Almost half of the interior office walls in the 25 stories occupied by Socony Mobil are movable partitions.

Experience in the new building has proved that entire walls can be taken down and re-erected elsewhere in a few hours. An office can disappear from one floor and reappear on another in a day. An entire department can be moved over a weekend, and be back in business in a new location Monday morning.

Using the prefab walls, it was found possible to accomplish as much changeover in one week as could have been accomplished in five weeks or more, using plaster walls, due to ease of erection and the fact that no drying time is required before painting.

In addition to all-steel panels, combination steel-and-glass walls were specified for use in parts of the Socony Mobil Building. Floor-to-ceiling unpolished plate glass panels were used. They have a texture all their own — a sort of knurled effect. A pleasing degree of translucency is achieved through the rough, unpolished surface of this relatively new building material.

Other features of the Socony Mobil Building have made valuable contributions to the flexibility of office space, according to the interior architect. A major advancement, Carr believes, is the wiring of the building. The building is the first major office building to boast a complete 440-volt heavy-duty electrical system. This allows it to absorb varying loads due to changes in air conditioning, lighting and appliance use without difficulty.

Flexibility of Walls Meets Changing Needs — Since Socony's move into its new home, over 20 percent of the original movable interior wall system had to be relocated. Thanks to the flexibility inherent in Hauserman movable walls, the company's changing space requirements were readily and economically accommodated. Experience has shown that an entire office can be relocated, or a new office created, in a matter of hours. And this can be done without interruption of the normal business routine.

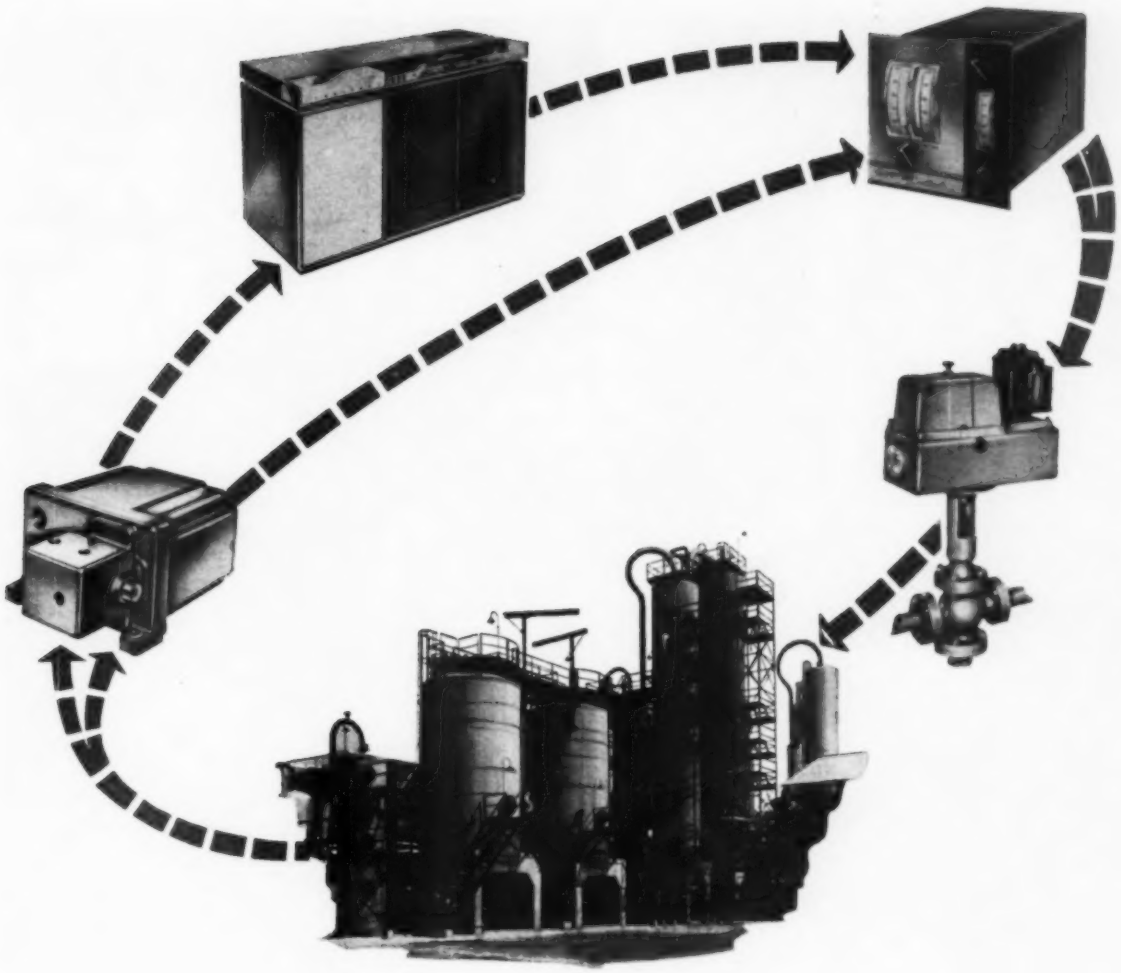
World's Largest Metal-Clad Building — New York's Socony Mobil Building, the largest office building to go up in New York City in a quarter century, is 45 stories high and contains 1.6 million sq ft of floor space. It is the first stainless steel-sheathed skyscraper and is the largest air-conditioned commercial structure ever erected. Its automatic elevator system is also the largest ever installed.

Ceilings were wired so that fluorescent lighting units can be switched from one panel of the ceiling to another with minimum effort. Similarly, air conditioning grills can be moved about at will. This provides flexibility not only for the company, but for the individual worker as well.

Further evidence of the extreme emphasis upon flexibility in all elements of the interior is the elevator installation, which is controlled by an electric brain and requires no operators. The electronic brain keeps the elevators in step with constantly changing traffic demand. It starts cars from terminals on a flexible schedule; balances and rebalances the cars to the needs of up or down traffic; and even runs full cars express.

"Every major feature of the Socony Mobil Building's interior measures up to the original concept of complete flexibilty, consistent with practical, pleasant working surroundings," Carr said.

* * *



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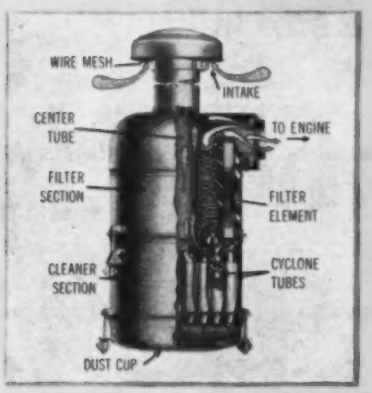
New Caterpillar dry-type air cleaner: CUTS SERVICING TIME 75% AVAILABLE FOR FIELD INSTALLATION on D8, D9, DW20, DW21 and No. 583

AIR-BORNE DUST is the deadly enemy of your engine's vital parts. Now, the new Cat dry-type cleaner gives positive protection against the entrance of harmful dirt—and its simplified servicing requires only about 5 minutes instead of 20 as with the oil-bath type!



THE NEW CATERPILLAR DRY-TYPE AIR CLEANER removes 99.8% of the air-borne dust from the intake air, even under the most severe conditions. Air enters through the stack cap where wire mesh screens out leaves and similar trash. Then the air passes down the center tube and swirls down the cyclone tubes. Centrifugal action throws the dirt against the sides of the tubes. From here 95% of the dirt falls through the funnel section into the dust cup, and the relatively clean air passes on to the resin-impregnated, cellulose filter. This element removes the rest of dirt and allows only clean air to enter the intake manifold. Filter elements can be cleaned and have lasted 3,000 hours without loss of efficiency.

SERVICE COSTS ARE SLASHED! Here is the experience of WEGCO Equipment Rental, Inc. of Cleveland, N. C., as told by the Superintendent of Maintenance, Mr. George R. Bell, "The dry-type cleaner saves us money. We have to clean our air cleaners daily because of dusty conditions. The oil-bath cleaners take about 20 minutes to clean and 5 quarts of oil. That's 60 cents in labor and $1.28 worth of oil, a total of $1.88 per machine. This dry-type cleaner takes only 5 minutes to service—about 15 cents labor. It saves us $1.73 on each machine every day."

SERVICE TIP: To empty dry-type cleaner dust cup, simply loosen wing nuts, remove cup, empty and replace. Occasionally the filter element will need cleaning. Merely remove it, blow off dust or wash in water, then replace.

YOUR CATERPILLAR DEALER has the full story on how much *you* can save by changing to the new and efficient Cat dry-type air cleaner. Remember, he stands behind every part he sells. See him today!

Caterpillar Tractor Co., Peoria, Illinois, U.S.A. **CATERPILLAR**

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YOUR *FISHER/MAN* STANDS BEHIND THIS

FOR Inherent Accuracy– Power–Speed– and Stability

FISHER TYPE 470 P.O.P.

- Delivers same power in either direction at any point of the stroke.
- No air set required—utilizes clean, noncorrosive air or gas up to 150 psi.
- Adaptable to virtually all types of valve bodies including Butterfly valves.
- Easily reversible actuator can be changed in the field.

This small, compact, pneumatically operated piston is available in five sizes with yoke sizes to fit any of the Fisher valve bodies including Butterfly valves. P.O.P. acts with high speed. For example, the 8½-inch size gives you 1.5 inches per second stroking speed. Write Fisher Governor for Bulletin E-59.

Type 470 P.O.P. With Fisher Bodies

Cylinder Size, Inches	Yoke Boss Size, Inches	Valve Body Size, Inches	Stem Size, Inches	Allowable Stem Force, Lbs.
4¾	2⅛	½—1½	⅜	1,500
	2 13/16	2—4	½	*
	3 5/16	5—8	¾	*
6⅛	2 13/16	2—4	½	2,500
	3 5/16	5—8	¾	*
8½	3 5/16	5—8	¾	5,000
10¾	5	10—16	1	8,000
13	5	10—16	1¼	12,000

*Limitation with these stems is dependent upon the maximum force available from each cylinder.

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD... CHANCES ARE IT'S CONTROLLED BY...

FISHER GOVERNOR COMPANY

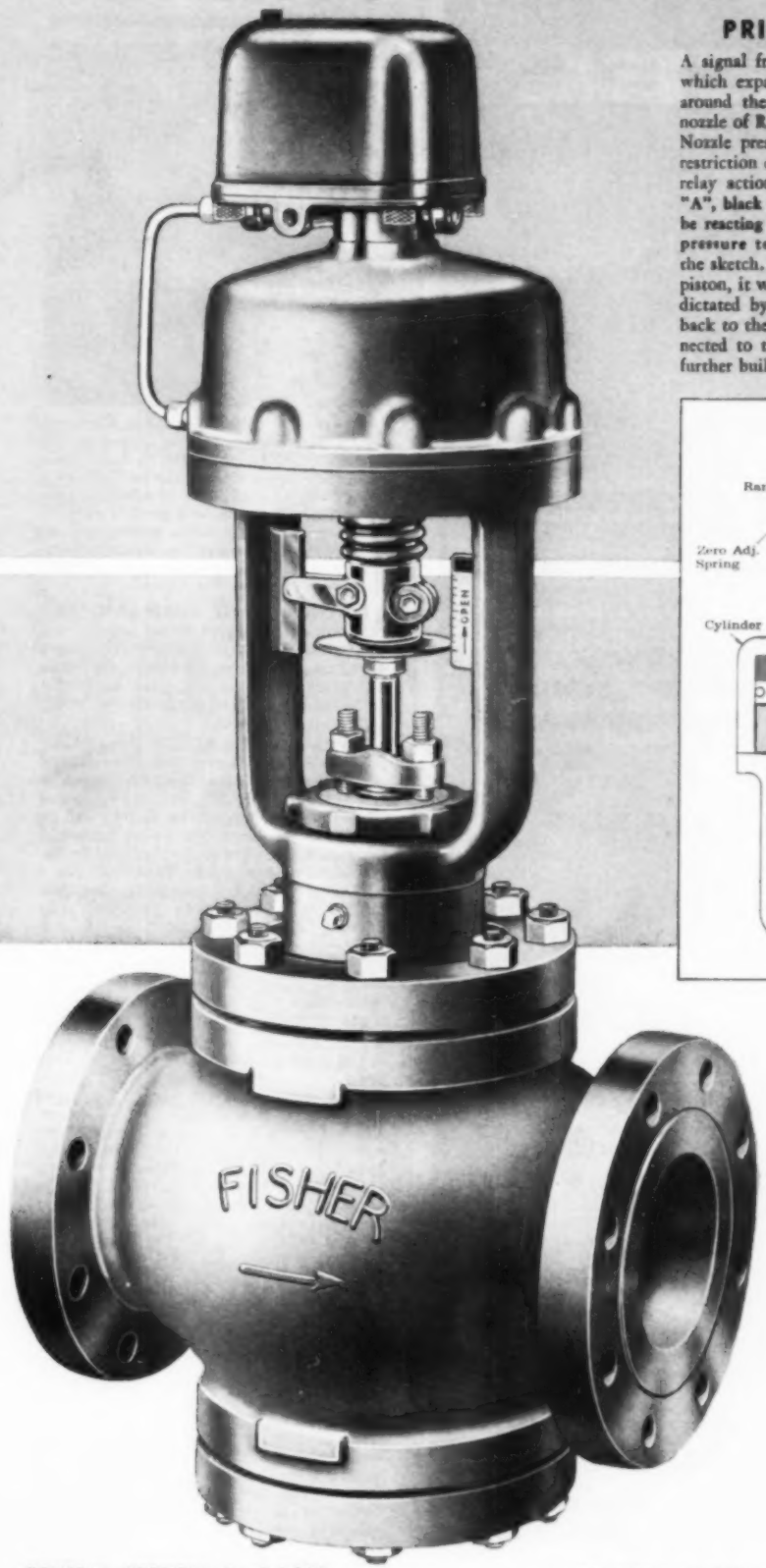
Coraopolis, Pa. / Woodstock, Ontario / London, England

Main Office and Plant: MARSHALLTOWN, IOWA

FISHER® Control

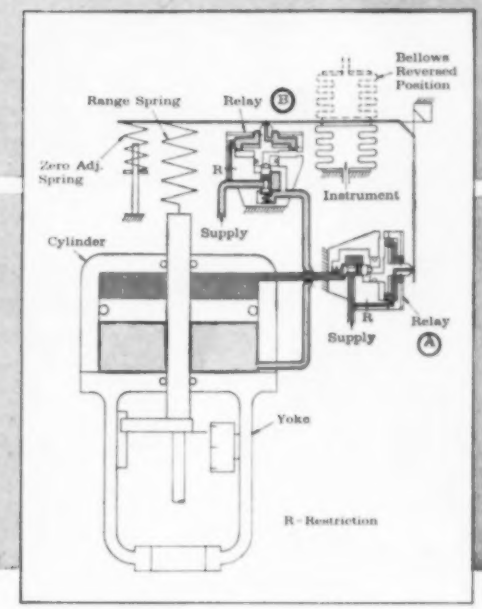
SINCE 1880

PNEUMATICALLY OPERATED PISTON...



PRINCIPLE OF OPERATION

A signal from the controller is received by the bellows which expand to move the beam. The beam will pivot around the fixed point and simultaneously uncover the nozzle of Relay "B" and cover the nozzle of Relay "A". Nozzle pressure will increase in Relay "A" due to the restriction created by the beam over the nozzle. Through relay action, the air pressure to the top of the piston, "A", black in the sketch, will be increased. Relay "B" will be reacting to the change in beam position to decrease the pressure to the under side of the piston, "B", red in the sketch. Due to the unbalanced pressures acting on the piston, it will move down, changing the valve position as dictated by the controller. The piston movement is fed back to the beam by means of a range spring that is connected to the piston rod extension, thus preventing any further build-up of pressure in the cylinder.



Exterior view of high pressure actuator. Type 470 mounted on a Design "A" body.

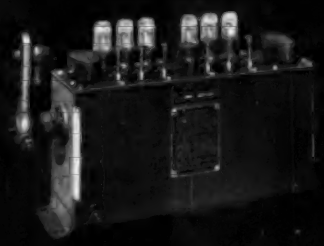
FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

MANZEL

accurate,
controlled,
timed
lubrication

Get the automatic, timed lubrication you need to protect valuable machinery, eliminate downtime, cut maintenance costs. Wide range of Manzel Lubricators and controls, in single and multi-feed units, will solve any lubrication problem. A Manzel field engineer will help select the model you need.

LUBRICATORS by Manzel



WRITE FOR COMPLETE CATALOG giving specifications and performance requirements to meet any of your lubricator needs.

Manzel

291 Babcock Street • Buffalo 10, New York

HOUDAILLE *Specialists in metering pumps and lubricators since 1898*

The Trade PARADE

Halliburton Oil Well Cementing Company Twin T-10 cementing unit is loaded at the Houston docks for shipment to South Australia. Halliburton will operate for Delhi Australian Petroleum Ltd. north of Adelaide, capital of South Australia, and provide cementing, fracturing and formation testing services. Halliburton is the Welex Inc. agent for Australia and will also provide wire line and perforating services.

THE WALWORTH COMPANY, New York, manufacturer of valves and fittings, announced that its subsidiary, the Grove Valve and Regulator Company, Oakland, California, will act as sales agent for specialized lubricated plug valve products to certain companies.

UNITED STATES STEEL Supply Division has purchased over two acres of land at Arlington, Texas, midway between Dallas and Fort Worth, as a site for a new office and warehouse. The facility will be located in the Great Southwest Industrial District. Construction is scheduled to begin within a few weeks. Plans call for a one-story structure covering approximately 39,000 sq ft to be completed later this year.

The new center will replace a smaller building U. S. Steel Supply has been using at 157 Pittsburg Street in Dallas since 1955.

ERIE METER SYSTEMS, Inc., which was purchased last November by the A. O. Smith Corporation of Milwaukee, Wisconsin, formally became a part of the latter company in February, instead of operating as a wholly-owned subsidiary. The company will become a part of the new Smith-Erie Division which will also include the A. O. Smith Meters and Service Station Pump Divisions in Los Angeles. The change had no effect upon employment, personnel, or production in Erie.

ROOTS-CONNERSVILLE BLOWER, division of Dresser Industries, Inc., Connersville, Indiana, is establishing a new district sales office at 1619 Ovid Street. Houston 10, Texas. Manager of the new office is Daniel Fulton. The territory consists of Texas, Louisiana and Southern Arkansas.

WILLARD F. ROCKWELL, JR., president of Rockwell Manufacturing Company, will head a heavy machinery industry committee for fund-raising on behalf of the largest campaign of citizen education in foreign policy ever undertaken by private auspices in this country.

RUST-OLEUM®

STOPS RUST!®

and matches ORIGINAL EQUIPMENT

COLORS

Distinctive as your own fingerprint. Accept no substitute.

How much does rusty equipment cost *you?* With Rust-Oleum, you STOP RUST—and you match original equipment colors, too, for long-lasting protection!

We want you to see for yourself how *easy* it is to use Rust-Oleum . . . actually take the brush and see how smoothly it works, how it dries to an *attractive, high-gloss finish* that resists sun, fumes, rain, heat, snow, salt air and salt spray, and blowing dust and sand. And the same formula can be applied by brush or spray. Just check the coupon for the color you want . . . and attach it to your business letterhead for a FREE TEST SAMPLE. No cost or obligation.

Your Rust-Oleum Distributor maintains complete stocks for immediate delivery.

ATTACH COUPON TO YOUR BUSINESS LETTERHEAD FOR FREE TEST SAMPLE

CHECK COLOR TO MATCH YOUR EQUIPMENT

RUST-OLEUM CORPORATION, 2631 Oakton St., Evanston, Ill.

Please send me a FREE TEST SAMPLE in the color checked:

- ☐ 769 Damp-Proof Red Primer
- ☐ H-50 Primer
- ☐ 634 Quick Drying Black
- ☐ 2766 High Gloss White
- ☐ 470 Ready Mixed Aluminum
- ☐ H-4 Caterpillar Yellow
- ☐ 722 Bethlehem Yellow
- ☐ 728 Old Emsco Green
- ☐ 726 New Emsco Green
- ☐ 727 New Unit Rig Gray
- ☐ 724 Waukesha Gray
- ☐ 725 New National Blue
- ☐ 723 Oil Well Orange

WHEELING
COUPLINGS
FOR OIL COUNTRY USE

LINE PIPE COUPLINGS — ⅛" to 12" — Seamless — Black or Galvanized
PLAIN TUBING COUPLINGS A. P. I. — 1" to 4" — Seamless
EXTERNAL UPSET TUBING COUPLINGS A. P. I. — ¾" to 3½" — Seamless
CASING COUPLINGS A. P. I. — 4½" to 13⅜" — Long or Short
HYDRAULIC COUPLINGS — ⅛" to 4" — Seamless
REAMED AND DRIFTED A. I. S. I. — ¾" to 12" — Seamless
DRIVE PIPE COUPLINGS — 6" to 12" — Seamless
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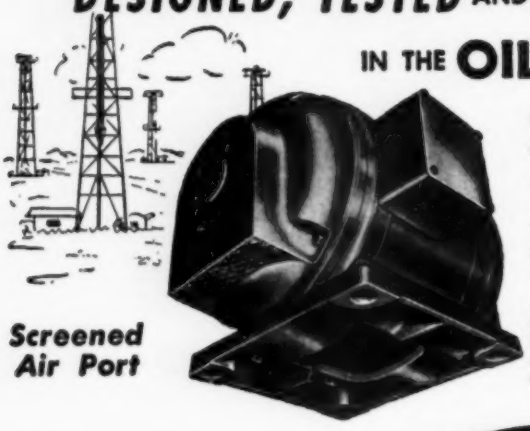
WHEELING MACHINE PRODUCTS COMPANY
WHEELING, WEST VIRGINIA
WEST COAST FACTORY: WOODLAKE, CALIFORNIA

DESIGNED, TESTED AND PROVEN IN THE OIL FIELDS



Unexcelled . . . for Outdoor Use

- DRIP PROOF
- VERMIN PROOF
- MOISTURE PROOF
- CORROSION RESISTANT
- FORCED AIR COOLED

All these features of Fieldmaster Ball Bearing Motors have been designed to overcome the rugged conditions of Oil Field requirements.

Screened Air Port

FIELDMASTER

CHECK THESE OUTSTANDING ADVANTAGES.

Heavy Cast base for alignment, stability, heavy duty, double-shielded, prelubricated bearings, reduces lubrication worries, high grade silicon steel in the magnetic circuit reduces iron losses . . . Wide variety of windings provides triple ratings, dual voltages . . . high torque licks heavy starting problems. High slip is available to take care of reciprocating load requirements encountered in pumping.

Write For Descriptive Literature.

BETHLEHEM STEEL CO. TULSA, OKLAHOMA
SUPPLY DIVISION
Manufactured by VALLEY ELECTRIC CORPORATION, St. Louis, 8, Mo.

Trade Parade

ALTEN FOUNDRY & MACHINE WORKS, Inc., has opened a new and larger equipment warehouse in Oklahoma City. The new facilities are located at 1607 S.E. Commerce Street.

CHEMICAL PLANTS DIVISION, Blaw-Knox Company, Pittsburgh, has been cited as the winner of the National Constructors Association's First Place National Safety Award for 1958. The award, for the 12 months ending September 30, 1958, is in recognition of the division's safety record for the year. The division had only four lost-time accidents during the year for a total of 60 man days lost time.

THE BABCOCK & WILCOX COMPANY'S tubular products division has been moved to 464 The Peachtree Building, 805 Peachtree Street, N.E., Atlanta 8, Georgia. It was formerly located at 830 W. Peachtree Street.

COLLINS RADIO COMPANY announced the creation of two new research and development divisions in its Central Division organization. The new divisions are designated C and D. Dr. R. L. McCreary will head Division C, which will deal with research programs in communication theory, propagation, antennas and radio astronomy. E. H. Fritze will head Division D, which will conduct instrumentation and flight control research programs.

Division A which remains under the jurisdiction of E. W. Pappenfus, will be concerned with high frequency equipment including airborne, vehicular, ground and amateur. The division is also responsible for the engineering support of the complete Collins reliability program. J. C. McElroy will continue to head Division B, which covers very high frequency/ultra high frequency communication and navigation in the areas of integrated airborne systems. This division will be responsible for Collins' part in Project Mercury.

THE SYSTEMS DIVISION of Consolidated Electrodynamics Corporation began operations in March as Consolidated Systems Corporation, a wholly owned subsidiary of CEC.

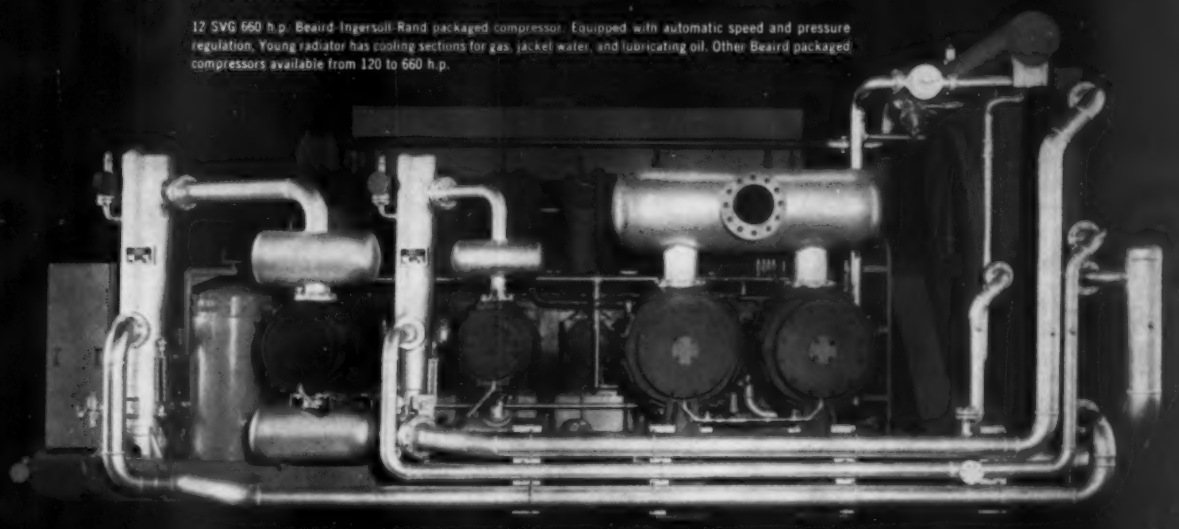
Philip S. Fogg has been elected board chairman of the new firm located in Monrovia, California, and Kennett W. Patrick, president. Patrick will also retain his present post as CEC vice president responsible for the parent company's Monrovia operations, which include the Transducer Division. Harry E. Burke, Jr., director of the Systems Division the past three years, has been named vice president and general manager of the new corporation. Also announced is the establishment of a government liaison office in Dayton, Ohio. James W. Spry, a military liaison engineer with Grand Central Rocket Company the past two years, will be in charge of the new office. He will report directly to William W. Bumpus, manager of CEC's government liaison office in Washington, D. C.

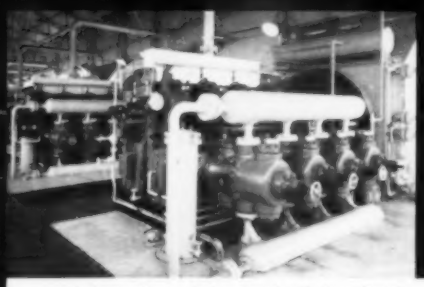
EBASCO SERVICES Inc. has completed arrangements for its affiliation with Pacific Planning & Research, Inc., a city planning firm with offices in Sacramento and Palo Alto, California.

FLUID PACKED PUMP COMPANY recently held a sales conference at the home office Los Nietos, California, to acquaint their division managers with newly developed products and processes and finalize planning for 1959. Executive vice president Sidney Shuman, general sales manager Don Vandenberg and chief engineer John Brennan had charge of the conference.

4-CYCLE DESIGN

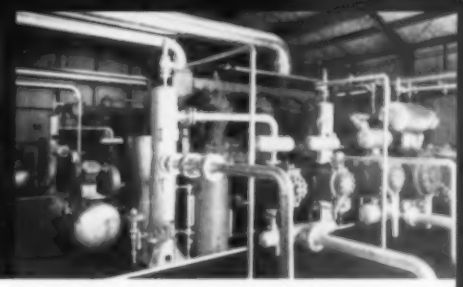
12 SVG 660 h.p. Beaird-Ingersoll-Rand packaged compressor. Equipped with automatic speed and pressure regulation. Young radiator has cooling sections for gas, jacket water, and lubricating oil. Other Beaird packaged compressors available from 120 to 660 h.p.





Carthage, Texas, plant equipped with three Beaird 8JVG 240 h.p. packaged compressors.

Sweetwater, Texas, plant equipped with one Beaird 10SVG 550 h.p. packaged compressor.



Tatum, Texas, plant equipped with two Beaird 10SVG 550 h.p. packaged compressors.

WHY 4-CYCLE DESIGN IS BEST FOR GASOLINE PLANTS

Fluctuating gathering system pressures are common in gasoline plant operation. An economical solution to this problem is the installation of Beaird-Ingersoll-Rand packaged compressors. The 4-cycle engine design permits use of automatic speed and pressure regulators which can vary engine speed from full to half . . . maintaining a smooth flow of power at any load. There is no need for expensive line pressure regulation in the gathering system.

Maintenance costs are lower too, as the 4-cycle engine can be operated at low speeds without carbon build-up or damage to the valve ports.

Further savings are possible on the 550 h.p. and 660 h.p. engines which are equipped with additional small compressor cylinder openings. A fifth or sixth compressor cylinder can be installed on these units to handle a refrigerant or gas from the re-absorber . . . saving the purchase and installation cost of an independent small compressor to handle this operation.

Qualified Beaird Gas Engineers are available to assist you in planning an economical solution to every compression requirement. Call or write today.

THE J. B. BEAIRD COMPANY, INC.
Shreveport, Louisiana
A Subsidiary of American Machine & Foundry Company

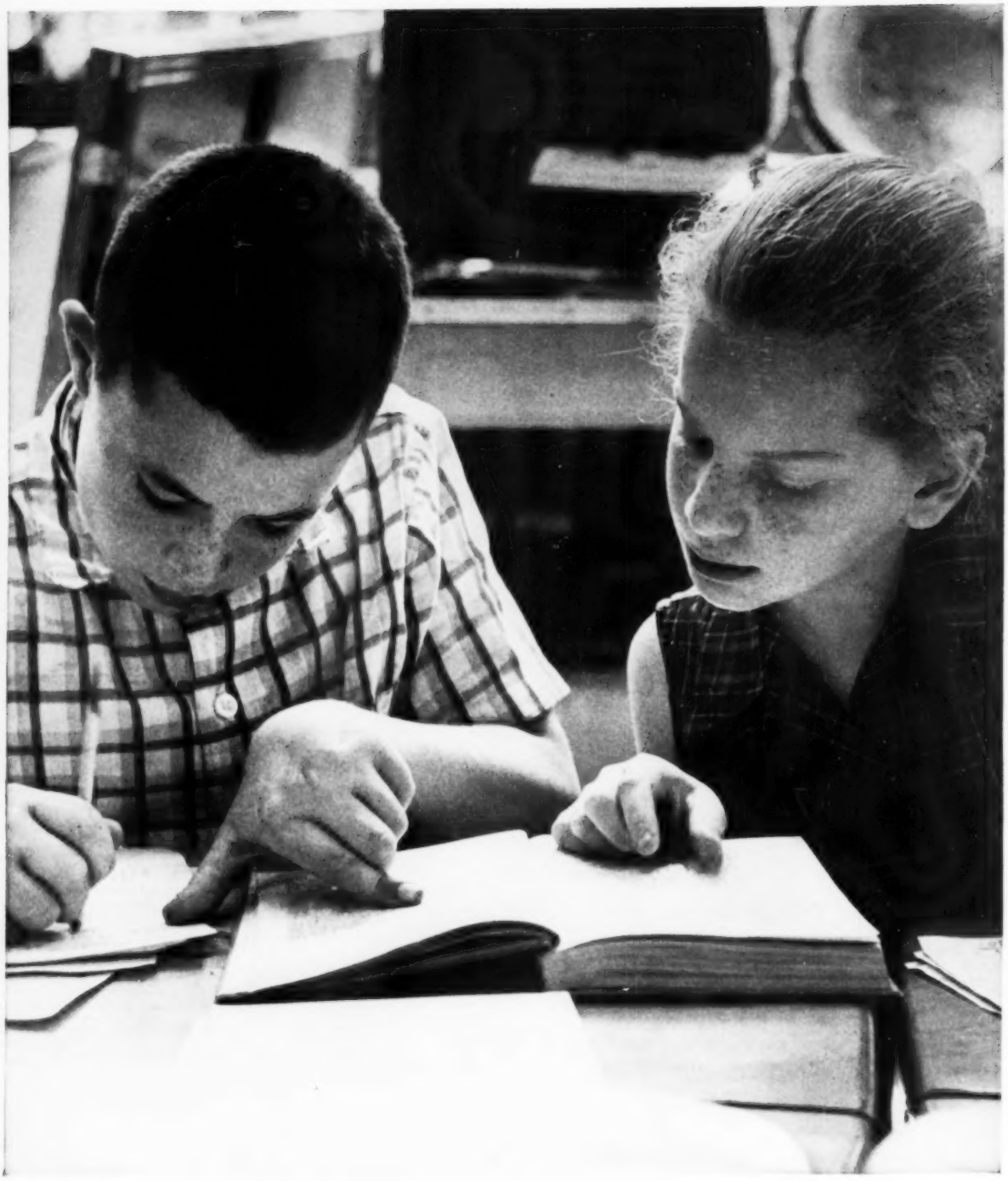
CHECK THESE EXCLUSIVE 4-CYCLE FEATURES:

Complete engine speed control
Gathering system pressure fluctuations absorbed by speed control
Constant quality fuel mix at all speeds
Long spark plug life
Small, accessible air intake piping
One air intake and one exhaust connection
No scavenging air manifolds for piping required

another AMF BEAIRD product

SALES OFFICES: Shreveport, New Orleans, Louisiana • New York, New York • Tulsa, Oklahoma • Houston, Corpus Christi and Midland, Texas and Cie. Ingersoll-Rand, Paris, France.

BEAIRD INTERNATIONAL, INC. SHREVEPORT, LOUISIANA • Sales Offices: Calgary, Alberta, Canada • Caracas, Venezuela.



"Nowhere is the need for knowledge about business more important than among America's young people . . . It is striking that they know so little through their formal education about the economic system which enabled them to go to school, in which most of them will work, and through which all of them will be supported at their graduation." —M. J. Rathbone, President

Esso

Standard Oil Company (New Jersey)

and affiliated companies

FOR FURTHER INFORMATION ON
ADVERTISED PRODUCTS, SEE READER SERVICE CARD

GENERAL ELECTRIC Computer Department's new headquarters and laboratory building in Phoenix, Arizona, have been formally opened. Linda Gosselin, 1959 Queen of Phoenix Rodeo Days and Computer Department employee, handed the Arizona Governor Paul Fannin the scissors and he cut the ribbon officially dedicating the first "home base" for the two-year-old department. Other members of the official dedication party were: Department General Manager Clair C. Lasher, Phoenix Mayor Jack Williams, Maricopa County Supervisor James Hart, and, acting as host and master-of-ceremonies, Raymond J. Barclay, Computer Department Manufacturing Manager.

▸ **ACF Industries, Inc.** J. M. Gruitch was named director of government products. He formerly was director of defense products for the American Car and Foundry division.

▸ **J. B. Beaird Company, Inc.** Joseph LaBarbera is advanced from manager of production to vice president of manufacturing.

▸ **Baroid Division** National Lead Company. O. A. Hicks, formerly superintendent of the drilling mud district at Oklahoma City, was transferred to Long Beach, California, as assistant area manager of the Pacific Coast area. Hubert Sanchez, formerly store manager at Long Beach, is named superintendent of the Southern California district with headquarters at Long Beach.

Dr. George R. Gray has rejoined the company as assistant manager drilling mud department after a year's absence.

▸ **BJ Service, Inc.** C. R. (Curt) Cross, Gulf Coast division manager, will make his headquarters in new Houston offices, where he will supervise 8 Gulf Coast stations and offices. Cross, a 7-year veteran of BJ Service, has had extensive experience in the Gulf Coast area.

▸ **Blaw-Knox Company.** Bruce Alexander was appointed manager of advertising and marketing services.

▸ **United States Steel Corporation.** E. E. Moore, assistant to the president and vice president, has retired, but will be retained temporarily by the corporation in an advisory capacity.

Paul R. Gross was appointed treasurer of U.S. Steel's United States Steel Supply Division. Gross succeeds C. H. Kraft who has been transferred to the corporation's New York offices as executive assistant-treasury department.

▸ **Bucyrus-Erie Company.** Three appointments in domestic sales department for commercial cranes and excavators are: Paul J. Thiel, sales administration supervisor; Byron A. (Bud) Haney, product development manager; and Frederick B. Shew, sales development manager.

Sales plans for both current and upcoming new products were laid at the Oil Center Tool Company recently during the annual sales meeting attended by all division managers. Al Wolff, seated, O-C-T president, presided at the three-day meeting with Charlie Jones, extreme left, vice president and sales manager. From left to right are Jones; Jim J. Humphries, city salesman, Dallas; D. L. Tanner, South Louisiana division manager (Shreveport); Walter Burke, South Texas division manager (Corpus Christi); Jack Simms, Rocky Mountain division manager (Casper); A. M. Taylor, Oklahoma division manager (Oklahoma City); H. C. Stewart, North Louisiana division manager (Shreveport); William Delaney, Four Corners division manager (Farmington); A. C. West, Western regional manager (Houston); M. E. Hunter, Eastern regional manager (Houston); Harry McDow, West Texas division manager (Odessa) and George Berg, Houston district manager (Houston).

Deal with the Mercantile and you deal with men who know the problems in oil and gas financing . . . and the soundest answers. Their experience and knowledge is here to help you.
Call RI 1-4181 or write
OIL and GAS DEPARTMENT
MERCANTILE NATIONAL BANK
DALLAS TEXAS

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

SEE FOR YOURSELF HOW

OSPHO®

PREPARES RUSTED METAL FOR PAINTING...

Send for FREE Test Sample

Eliminate sand-blasting or flame-cleaning. Simply brush off loose rust and apply OSPHO on the rusted metal surface. One application *kills* the rust and provides a *sound* base for your regular maintenance paint. Rust action is stopped — paint jobs last much longer.

OSPHO is *not* a primer — *not* a paint. It is a carefully balanced phosphate chromate metal treatment which chemically changes rust (iron oxide) into iron phosphate — an inert, hard, gray surface ideal for painting.

OSPHO provides excellent coverage . . . a gallon treats up to 600 square feet. And cost is low. Available in 1-gallon containers (in cases of 4), 5-gallon pails, 50-gallon barrels. Colorless, non-toxic, non-flammable. Available through distributors.

Repeat orders over the past 16 years are proof of OSPHO's effectiveness. *See for yourself . . .*

Write Now For FREE Test Sample
(on company letterhead)
and descriptive literature

TREATS NEW METAL TOO!
When applied on new ferrous metal, galvanized iron and aluminum, OSPHO imparts a slight etch to the metal, insuring tight bond of the paint coat that follows.

ONLY OSPHO KILLS THE RUST

RUSTICIDE PRODUCTS COMPANY
3125 Perkins Avenue • Cleveland 14, Ohio

QUALITY MAINTENANCE PRODUCTS SINCE 1917

Trade Parade

▸ **National Cylinder Gas** Division of Chemetron Corporation. Clarence H. Reinecke was promoted to manager of the Milwaukee district office. He replaces A. L. Breyvogel, who retired after 18 years with the company.

▸ **National Tube Division,** U. S. Steel Corp. H. Maurice Banta was appointed assistant director, research and technology. Banta has been a research associate at Battelle Institute.

▸ **Tretolite Company** division of Petrolite Corporation. Alan H. Brown, who has been on special assignment at the company's plant and main offices in St. Louis, Missouri, has been assigned to Eastern Venezuela as field engineer with South American Petrolite Corporation.

▸ **Rockwell Manufacturing Company.** Ralph A. Purcelli, executive assistant to the general manager of the Barberton, Ohio, plant, was named general manager of the Porterville, California, plant.

▸ **Roots-Connersville Blower,** a division of Dresser Industries Inc. D. M. McDowell was appointed director of engineering and will have responsibility for direction and management of all phases of the engineering program.

▸ **Pfaudler Permutit Inc.** Vice president George C. Calvert, previously manager of Pfaudler's Elyria plant, will move to Rochester to supervise all Western Hemisphere operations outside of the U. S. Calvert will also assist in supervising the company's other foreign operations. E. W. Zoller becomes manager of domestic manufacturing operations. He was manager of the Rochester plant.

Thomas Griswold is manager of the Elyria plant replacing Calvert. Griswold was assistant plant manager for 6 years. H. R. Derleth was appointed to assistant plant manager of Rochester, formerly chief industrial engineer.

▸ **Robertshaw-Fulton Controls Company.** Robert R. Rosborough was named contract administrator at the aeronautical and instrument division. Rosborough was formerly proposal sales manager for that division.

▸ **The Ruberoid Company.** E. J. O'Leary, president and chief executive officer, was elected chairman of the board. Herbert Abraham, chairman since 1954, has resigned that position but will continue to serve as a director and as chairman of the executive committee. E. N. Funkhouser of Hagerstown, Maryland, was elected to the board. O'Leary will continue to serve as president and chief executive in addition to his new position. Funkhouser replaces the late John J. Flood.

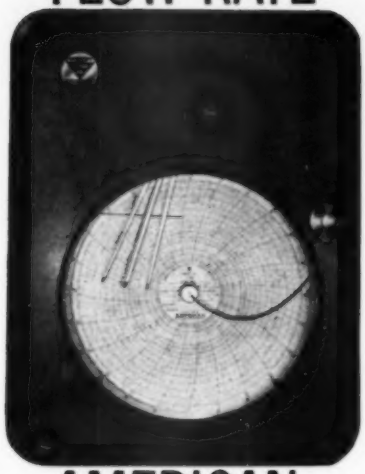
▸ **Reed Roller Bit Company.** Charles B. Caldwell has recently joined the sales force as regional representative for the Houston, Texas, Gulf Coast area.

▸ **Southwestern Industrial Electronics Company,** a division of Dresser Industries, Inc. Rex B. Grey is appointed manager, control division. He was with the Texas Apparatus Company.

▸ **Brown Oil Tools,** E. C. Chamblee is the new superintendent of the service division. He will be in charge of all service and field sales personnel. A. H. Womack will take over managing the Louisiana division, replacing Chamblee.

▸ **BJ Electronics,** Borg-Warner Corporation. James Mills was named contract sales manager with headquarters at Washington, D. C. He was formerly eastern military and industrial products representative. P. C. Valli, former special agent of the FBI was named chief of security.

PRECISION MEASUREMENT AT ANY FLOW RATE



AMERICAN-WESTCOTT A-88

ORIFICE METERS

Versatile American® Series A-88 mercury-type orifice meters meet the toughest flow measurement requirements – working pressures to 5,000 psi – interchangeable 10, 20, 50, 100 and 200-inch ranges. Recording meters may be equipped with 0-150° F. standard temperature element. Integrating meters integrate static and differential pressure, providing totalized flow indications. Telemetering equipped meters transmit integrated indications to remote locations.

- Manometer body easily cleaned – does not affect calibration.
- Tamper-proof calibration – simple, positive adjustment of float lever arm length.
- Interchangeable ranges – no manifold piping changes.
- Teflon-packed stuffing box is pressure tight, nearly frictionless, never needs lubrication.
- Teflon-packed pulsation dampener externally adjustable under full line pressure.
- Check valves give positive shut-off for over-range protection.

AMERICAN® METER COMPANY
INCORPORATED (ESTABLISHED 1836)

General Offices: Philadelphia 16, Pa.
Sales offices in principal cities

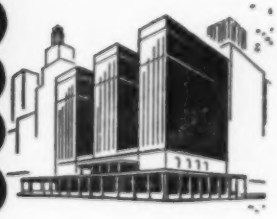
There's no paint on Lufkin Chrome Clad Anchor Tape lines.

The bold, black markings are bonded to the basic metal . . . protected with several electroplatings that give extra strength to the line. The final metal coat is Lufkin's exclusive Chrome Clad finish. Glare free, smooth, rust resistant . . . the most durable tape line you can buy.

Anchor lines are replaceable in the genuine-leather, hand-stitched case. Available with markings in feet, 10ths and 100ths.

THE LUFKIN RULE COMPANY
TAPES • RULES • PRECISION TOOLS
SAGINAW, MICH. • NEW YORK CITY • BARRIE, ONT.

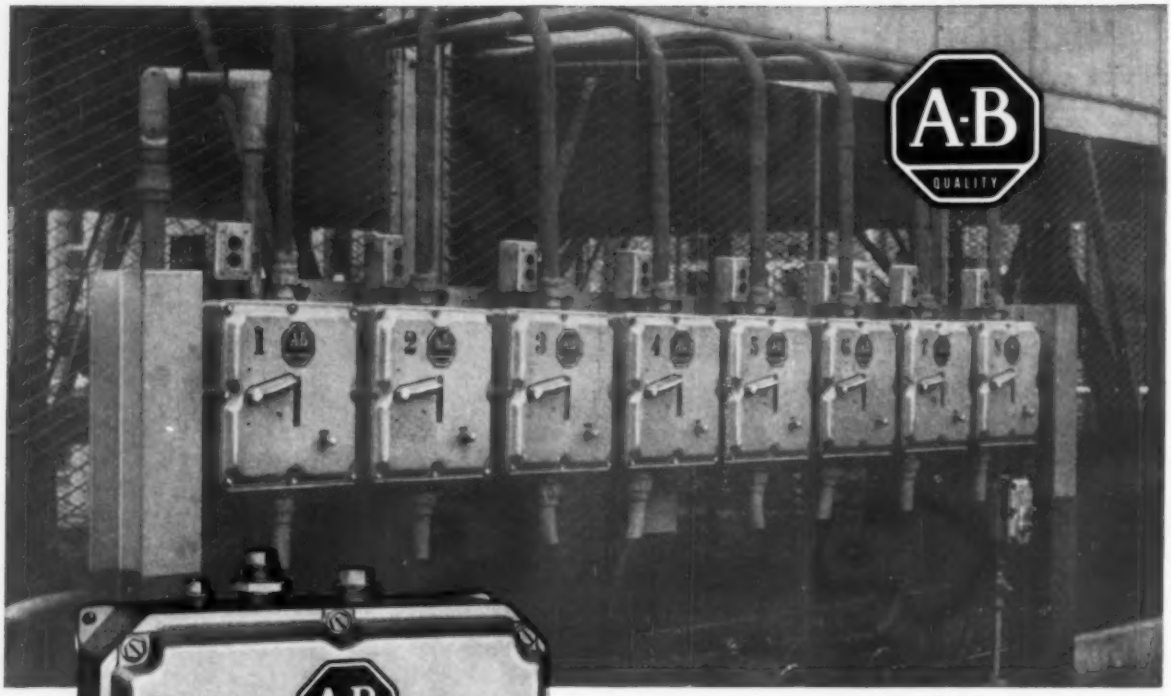
Houston Hospitality at its Best!

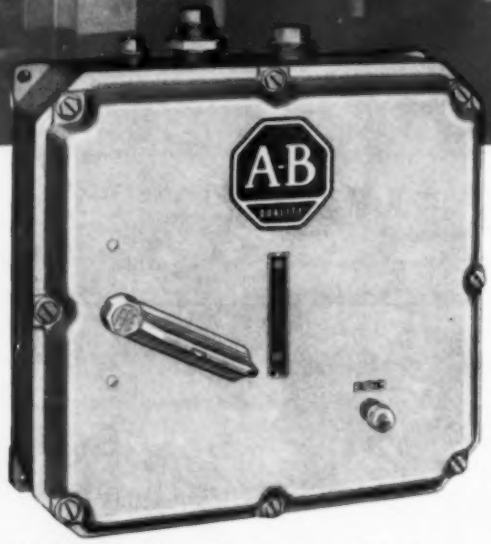


When business or pleasure brings you to **Houston,** enjoy the superlative comforts and conveniences of the **NEW Rice Hotel** — ideally located in the heart of the downtown section. Enlarged, remodeled, and beautifully redecorated from top to bottom, The **Rice** is now truly **"Houston Hospitality at its best."**

★ *Home of the* **PETROLEUM CLUB** ★

The Rice Hotel
HOUSTON, TEXAS





Bulletin 713 Combination Starter with circuit breaker in NEMA Type 9 enclosure for hazardous dust locations.

Round-the-clock safety . . . and reliability . . . without costly maintenance

When hazardous locations require starters in explosion-proof enclosures, it usually means costly maintenance. But *not* when you use A-B starters, because you eliminate the expense of removing and replacing bolted covers for "regular" inspection! In all A-B starters there is only ONE moving part. This is your assurance of *millions* of trouble free operations. There are no bearings to stick . . . no flexible jumpers to break. And the double break, silver alloy contacts never need servicing —they remain in perfect operating condition until completely worn away. The permanently accurate thermal overload relays are another "plus" feature. Insist on Allen-Bradley controls . . . and save on maintenance throughout the years.

NEMA 7
For Hazardous Gas Locations

NEMA 4
Watertight Weatherproof

NEMA 8
For Corrosive Hazardous Gas

NEMA 11
Corrosion-proof

ALLEN-BRADLEY
Quality Motor Control

Allen-Bradley Co., 214 W. Greenfield Ave., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

Dow Chemical Company. Frank J. MacRae has been named manager of plastics technical service. He succeeds Dr. W. C. Goggin, who replaces C. B. Branch as manager of the plastics department. Branch was named manager of all Dow overseas activities outside the North American continent.

Fielding H. Yost Jr., manager of the Cleveland sales office, was advanced to assistant to the director of corporate relations. He will be located at the company headquarters in Midland, Michigan. Simultaneously, the promotion of Thomas M. Gow to succeed Yost was announced.

Dresser Manufacturing Division, Dresser Industries, Inc. E. R. Carey was promoted to assistant sales manager, regular products. John P. Lord, formerly business manager for welding fittings, was promoted to manager of general markets sales, replacing Carey.

Fairbanks, Morse & Company. Charles C. Libby, formerly electrical department manager of the Fair Lawn, New Jersey, branch, was appointed manager of the electrical division. He will be located in the sales division headquarters at Freeport, Illinois, and replaces W. H. Kingsley who has resigned.

Fischer & Porter Company. Horace F. Richter Jr., was named to the newly-created post of sales coordinator. In his new position, Richter will implement sales policies, coordinate operating activities between the company's home office and its field force, and direct the company's sales training program.

General Electric Company. Vincent P. Purcell was named sales manager-industrial turbines for the small steam turbine department.

John E. Strehle was appointed Southern Florida district sales manager at Pompano Beach and Jack Najork has been placed in charge of the G-E two-way radio office in Chicago, both in the communication products department.

Dr. Charles E. Reed was named general manager of the metallurgical products department in Detroit. He succeeds Kenneth R. Beardslee, who becomes a consultant for the department.

Great Lakes Carbon Corporation. Zaven Vetzmadian was named sales correspondent for the mining and mineral products division, Dicalite export department.

Grove Valve & Regulator Company. Jack Huddle has joined the sales engineering staff, and will be headquartered in Grove's Odessa, Texas, offices.

Jones & Laughlin Supply Division. New salesmen are: Jack H. Rankin, assigned as salesman at Kermit, Texas; John W. Snyder, salesman at Alice, Texas; Gordon N. Jones to the Williston, North Dakota, store; Gary N. Griffiths, Odessa, Texas; Larry F. Ransdell, at J&L's Oklahoma City sales office; and Jerre B. Williams to El Dorado, Arkansas.

Two changes in the Canadian field sales organization are: J. R. Windle, salesman at Edmonton, Alberta, is transferred to Calgary, Alberta; and W. J. Chisholm, former store manager at Drayton Valley, Alberta, is appointed salesman and transferred to Edmonton.

W. C. Norris, Manufacturer, division of Dover Corporation. A. A. Hardy has been appointed to the newly created position of director of engineering and research. Prior to his promotion Hardy was chief engineer.

Orbit Valve Corporation. R. A. Lauducci was appointed chief engineer. Lauducci was associated with Midwestern Instruments, Inc., as coordinator of planning for all engineering projects.

Youngstown Sheet and Tube Company. Clarence E. Short, assistant district sales manager in Minneapolis, becomes Minneapolis district sales manager. He succeeds Charles S. Hogan, who has retired. Albert S. Harris, a member of the oil country tubular goods sales staff in Youngstown since 1955, becomes assistant manager, oil country tubular sales, with headquarters in the general offices.

Magnet Cove Barium Corporation. Five major executive changes are: I. W. Hoskins appointed to the position of senior vice president-marketing. He was formerly president and general manager of Mud Supply Company, Inc. Orien W. Van Dyke promoted to senior vice president-production and technical, was formerly vice president and technical director. Floyd A. Enz, formerly vice president-finance and secretary-treasurer, promoted to senior vice president-finance. Frank H. Loe, formerly sales manager of the drilling mud department, promoted to vice president and sales coordinator. John E. Lyons, formerly assistant sales manager of the drilling mud department, will succeed Loe.

Otis Engineering Corporation. R. Wayne Dickeson is named manager of the Corpus Christi division replacing Bob L. Crain who was transferred to the firm's Eastern division in Longview. Dickeson was formerly division manager of the Odessa branch.

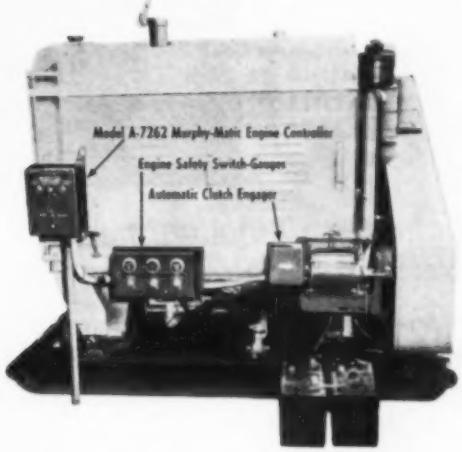
Turner G. Garwood was named sales representative for Europe, Africa, and the Middle East. He will make his headquarters in Geneva, Switzerland.

Lone Star Steel Company. Robert R. Reed was named regional sales manager of the Gulf area.

MURPHY

See

Safety and Automation Switch-Gauges at I. P. E.



Pictured above — fully automatic pipeline pump — Murphy-controlled.

Be sure to visit our International Petroleum Exposition Exhibit in the California Building . . . and our plant at

3131 South Sheridan Road in Tulsa

Most complete line of Automation controls for Oil and Water level, Water, Gas and Oil Temperatures, Gas Compressors, Water Flood and Pipeline Pump Stations.

Safety fuel valves for Diesel and Gas
Custom made panels to your specifications

See our ad in COMPOSITE CATALOG

FRANK W. MURPHY MANUFACTURER, INC.
RANCH ACRES STATION
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MURPHY SAFETY SWITCH OF CALIFORNIA
11812 Davenport Road • Los Alamitos, Calif.

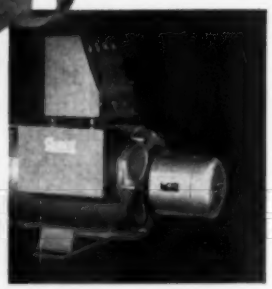
FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

the NEW LOOK *in* GENERATOR DESIGN

on large Onan gasoline and diesel plants

ONAN'S NEW MAGNECITER GENERATOR

TYPICAL ROTATING EXCITER GENERATOR



Eliminates all moving parts in exciter and voltage regulator

Steps up performance in primary or emergency standby installations

- ✓ ***FASTER VOLTAGE RECOVERY***—Rated voltage is restored within one second after load is applied or removed, compared to 5 seconds with rotating exciters.
- ✓ ***LESS VOLTAGE FLUCTUATION***—Voltage fluctuation with load changes is less than half that of standard-type generators.
- ✓ ***GREATER RELIABILITY***—Eliminates hundreds of electrical connections, the commutator and its brush rig.
- ✓ ***FEWER ADJUSTMENTS***—No extra sensitive adjustments necessary. Regulator has no delicate multiple contact points.
- ✓ ***EASIER SERVICING***—All exciter and regulator components are easily accessible. No dismantling necessary.

SEE US AT THE OIL SHOW

These new plants and Onan's new standby power system for microwave will be displayed.

New Magneciter generators are now standard equipment on all Onan Electric Plants of 100, 125, 150, 175 and 200KW, as well as on many smaller sizes. A choice of Diesel or gasoline engine power is available on most Magneciter-equipped models. Complete specifications on any or all Onan units will be sent on request.

Call the Onan distributor listed in your telephone book or write directly to us.

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INSTANT START, NO BATTERIES WITH I-R

AIR STARTING MOTORS!

Dependable: Fast, positive starts regardless of temperature. Made by the originators of Air Starting Motors.

Low cost: Eliminates batteries, generators, electrical parts and their maintenance.

Less weight: I-R Air Starting Motor installations weigh less than conventional batteries and generators . . .

Three sizes: I-R Air Starting Motors are made in models to meet the needs of almost all stationary, auxiliary and motive engines.

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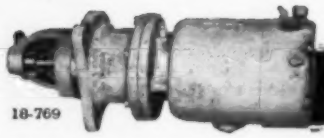

Write for new Air Starting bulletin Form 5094D.

18-769

CONTROL PARAFFIN

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LOW, LOW COST!

NOW is the time to set up a "control program" with the constant injection of economical BrakeSol. . . . the chemical that holds paraffin in suspension from formation to refinery. BrakeSol is the most effective chemical for treating all types of paraffin conditions. It is approved by refiners . . . contains no chlorinated solvents or other organic halides or sulphides. Contact your nearby BrakeSol Treating Engineer or Supply Store for information on how your paraffin problems can be eliminated economically. See our Exhibit at the IPE.

BrakeSol INC.

P. O. BOX 9506 • OKLAHOMA CITY, OKLA

EXPORT DISTRIBUTOR THE NATIONAL SUPPLY CO., EXPORT DIVISION

Laugh with Barney

"And do you love me, your majesty?" asked wife No. 999, anxiously.

"I certainly do, my dear" King Solomon assured her. "Why, you are one in a thousand."

"Your wife has been delirious all day," said the nurse, in a worried tone, "calling for you and crying for money."

"Hah!" snorted the husband. "Delirious, hell!"

The hostess was pressing her guests to provide entertainment.

"Is there any instrument you can play, Mr. Jenkins?" she asked.

"Not away from home," he replied.

"What do you play at home?" she inquired.

"Second fiddle," Jenkins murmured solemnly.

A French dancer has insured her legs for $500,000. During her performance her legs are covered by the policy only.

"I wonder if I'll lose my looks when I'm as old as you?"

"You'll be lucky if you do, dear."

Timid wife (to husband who has fallen asleep at the wheel): "I don't mean to dictate to you, George, but isn't that billboard coming at us awfully fast?"

Have you heard about the guy who was beaten up while fighting for a woman's honor? It seems that she wanted to keep it.

The taxi driver put on his brakes suddenly, and came to a stop.

"What's the matter?" asked the man in the back seat.

"I heard the young lady say 'Stop'."

"Never mind that. She wasn't talking to you."

The clanging noise made by the garbage collectors aroused the family. The housewife suddenly remembered she had forgotten to put out the garbage. With her hair in curlers and her face shiny with various creams, she sleepily leaned out the window and called to the collectors, "Am I too late for the garbage?"

"Certainly not," replied one of the collectors, "hop right in."

It's not a bad idea to keep your words soft and sweet because there's apt to come a time when you will have to eat them!

If women ever get equal rights with men — it will be quite a come-down for them.

Canned and frozen juices are becoming more and more popular, but most men still prefer to squeeze their own tomatoes.

Did you hear about the attractive girl who is so sexy the birds and bees study her?

A shapely secretary, who had recently been transferred from the Chicago office to the New York office of a big firm, stepped into the office of her new boss, and asked, "What exactly are my duties?"

"Oh, just do exactly as you did in the Chicago office," explained the top man.

"All right," she answered matter-of-factly, "kiss me and let's get started!"

CLASSIFIED

FOR SALE

WIRE LINE TRUCK — 1956 International, Model S174 — 172" wheel base. Heavy duty throughout. Equipped with PATSO body and winch assembly. Like new. Stainless steel reel with capacity of 17,000' of 3H4 cable. Now has approx. 14,500' of .425 — 3H4 cable. Available with some electrical equipment. *Write* **Mr. Phillips or Mr. Dale, P. O. Box 1500, Denver 1, Colo.**

FOR SALE

WIRE LINE TRUCK — F6 Ford. Equipped with PATSO body and winch assembly. 32" between flanges x 31" diameter x 16" center. Now has 12,000' of .425 — 3H4 cable. Available with some electrical equipment. Excellent condition. *Write* **Mr. Phillips or Mr. Dale, P. O. Box 1500, Denver 1, Colo.**

CLEANING EQUIPMENT

For plant maintenance and tank cleaning, hot "jet stream" cleaning, with Sellers Hydraulic Jets. Send for Bulletin 424-B.

Sellers Injector Corp.
1608-G Hamilton Street, Philadelphia 30, Pa.

Hot Springs for your health
60 miles from Los Angeles in
SAN BERNARDINO, CALIF.

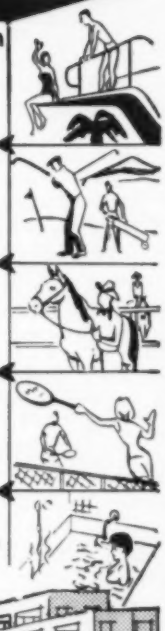
Situated on 1700 acres of woodland—overlooking mountains, vineyards, and lovely gardens. 2,000 feet elevation—delightful year around weather.

Luxurious air-conditioned guest rooms and bungalows. Famous Restaurants, Bar. Outdoor pools, tennis, horseback riding, shuffleboard, etc. 18-hole Golf Course available. Dancing nightly.

World-famous mineral waters and baths.

From $10 per day (European Plan)

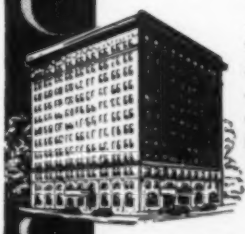
FOR RESERVATIONS, PLEASE WRITE TO:
CHARLES KERN, General Manager



Arrowhead Springs
HOTEL and SPA
SAN BERNARDINO, Calif.

Tops in Everything

CONVENIENT



Ideally located in St. Louis, two short blocks from the Union Station and in the center of the Wholesale District . . . Preferred, always by experienced travelers because of its outstanding advantages— Every room with combination tub and shower . . . and circulating ice water.
Delicious food . . . cheerful service.

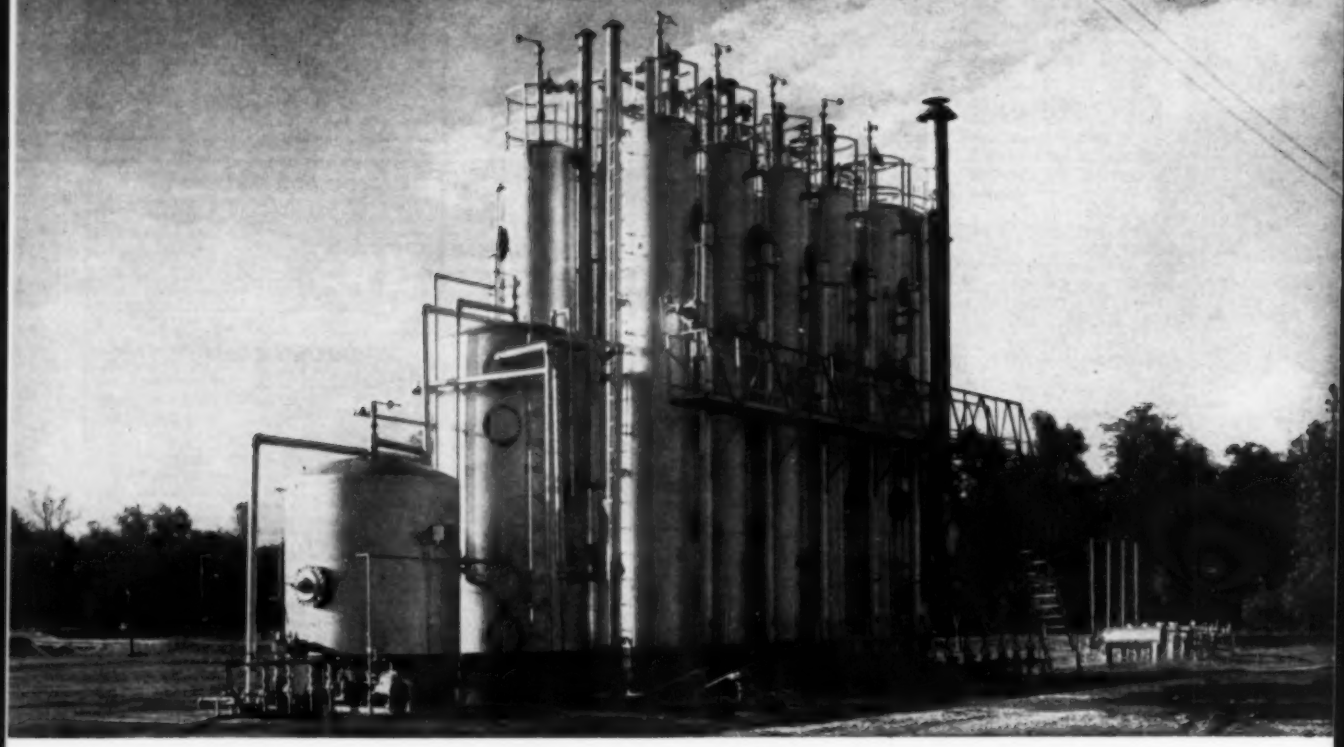
350 AIR CONDITIONED ROOMS from $3.50

HOTEL LARIDGE

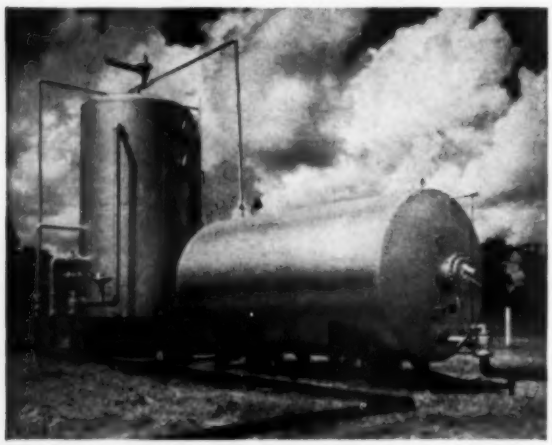
LOCUST ST. AT EIGHTEENTH
Member Diners' Club
Free Parking
ST. LOUIS

NATIONAL

CLOSED WATER DISPOSAL SYSTEM



Centralized treating battery of National Emulsion Treaters, a Vertical Water Conditioner and a Vertical Accumulator and Back Wash Tank in South Louisiana for a Major Oil Company.



Vertical Water Conditioner and a Horizontal Accumulator and Back Wash Tank in Northern Louisiana.

The National Emulsion Treaters send oil of pipeline specifications to the stock tanks. Water treated out of the oil passes to Vertical Water Conditioning Tank. In this vessel any free oil is skimmed off and the water then passes through an excelsior section where the smaller particles of oil still entrained in the water stream are coalesced. This oil then rises and is drawn off to stock. The oil-free water flows to the bottom compartment where it is filtered through a fine graded material supported on a porous block underdrain.

After filtering, the conditioned water accumulates in the accumulator for subsequent injection in the disposal well and for backwashing the filter.

These systems are available in a wide range of capacities and sizes from over 50 Warehouses in the United States, Canada and Venezuela.

National Tank Company has successfully solved water treating and disposal problems for over 15 years.

Write for Tank Topics
"Water Treating, Flood and Disposal"

It's a National®

NATIONAL TANK COMPANY

TULSA, OKLAHOMA

a higher degree of fracturing versatility!

with HALLIBURTON

Since the beginning of hydraulic fracturing, the petroleum industry's greatest volume dollar returns from any fracturing treatment has been due to the broader, more versatile application of *SANDOIL*.

YOU GET THESE 5 BIG PLUS FACTORS WITH EVERY *SANDOIL* JOB:

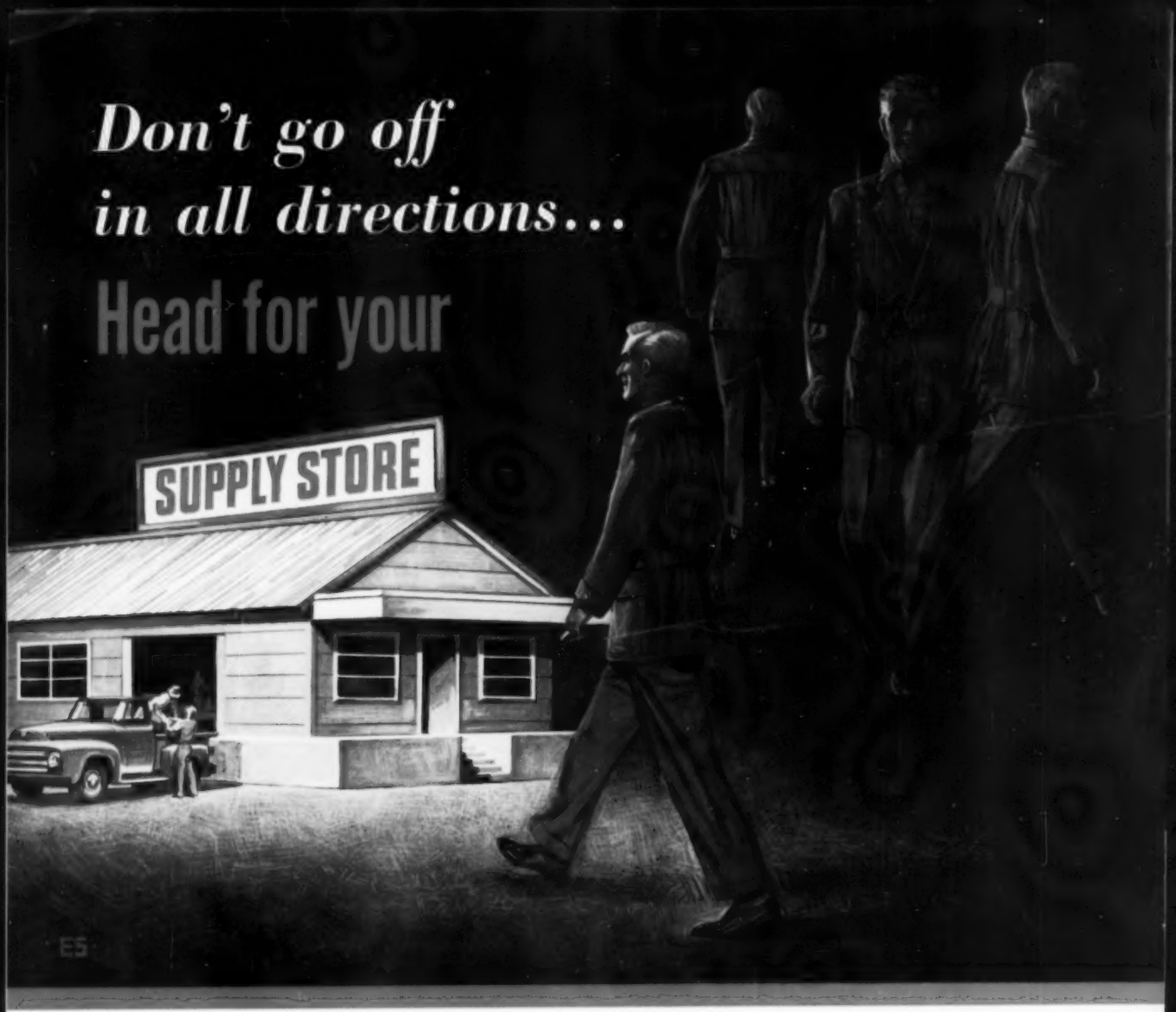
1. ECONOMY
2. SIMPLICITY
3. AVAILABILITY
4. VERSATILITY
5. COMPATIBILITY

Ask your local Halliburton Representative for your *FREE* copy of "Elements of Hydraulic Fracturing" and read the "Sandoil Story" on page 9. The exceptional value of this technique merits your further investigation.

HALLIBURTON FRACTURING SERVICES

HALLIBURTON OIL WELL CEMENTING COMPANY • DUNCAN, OKLAHOMA

"CONTINUE TO LOOK TO HALLIBURTON – FOR LEADERSHIP"



. . . it's stocked with the equipment you need for your immediate and long range drilling and production needs. The convenience of the SUPPLY STORE, the specialized knowledge of its personnel, and their conscientious service combine to save you many hours and many dollars on your well.

Among the wide variety of equipment available, you will find quality Baash-Ross slips, rotary bushings, safety clamps, spiders and other Baash-Ross drilling and production equipment. For convenience in buying —*there's no need to go off in all directions.* Just head for your SUPPLY STORE.

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BAASH ROSS

JOY

Of Things To Come . . . In Oil

CONTRACTORS ARE FRAMING A BRIGHTER DRILLING PICTURE as U. S. and Canadian active rig count pushes last year's levels. Total number of rigs operating has been rising steadily since ordinary low February levels. Louisiana and New Mexico are reporting largest recent gains, while West Central Texas, Kansas and Mississippi are showing biggest annual increases. Drilling contractors are setting pattern for a better well completion record for the year, previously not estimated to be "appreciably" higher than the 48,000 wells drilled in 1958.

SECONDARY RECOVERY PLANS FOR ANETH FIELD AREA, in the Four Corners region, may introduce large-scale projects that border on "revolutionary." Southeast Utah Engineering Committee, which reported its views on several type projects for the Desert Creek area to the Utah Commission this month, represents thoroughness with which it is attempting to raise ultimate recovery levels and field life from dismal reserves report delivered by Core Labs (Core study gave Aneth a 15-year life.) Engineering committee, composed of operators' representatives are suggesting, among other things, a CO_2-water flood.

MORE PENNSYLVANIAN TESTS IN COLORADO sector of Paradox Basin are expected to spring up near The Texas Company's No. 1 Ute Mountain Tribal in Montezuma County. The new Four Corners discovery flowed at the rate of 1236 bbl per day of 41.8 deg oil on 1-in. choke from 5850-55 ft — nine miles from McElmo Creek field (in Utah). The California Company's well, 2 miles southwest, was "near miss" in Pennsylvanian because high water-oil ratio. Other tests are staked; some are underway; Tennessee Gas has cored slight shows in Pennsylvanian at its Poison Springs area prospector.

STEEL TUBULAR GOODS SUPPLIES WILL DIMINISH until summer, disappearing in wake of anticipated steel strikes. Most regional pipe mills are operating at capacity and report that casing and tubing orders are booked through the first half of 1959; some are talking about third-quarter deliveries. Some mills report that line pipe orders moving slightly slower. Most producers are admittedly "stockpiling"— a non-existent practice in 1958.

THIS IS THE IMAGE OF CF&I...

maker of steel products for every industry

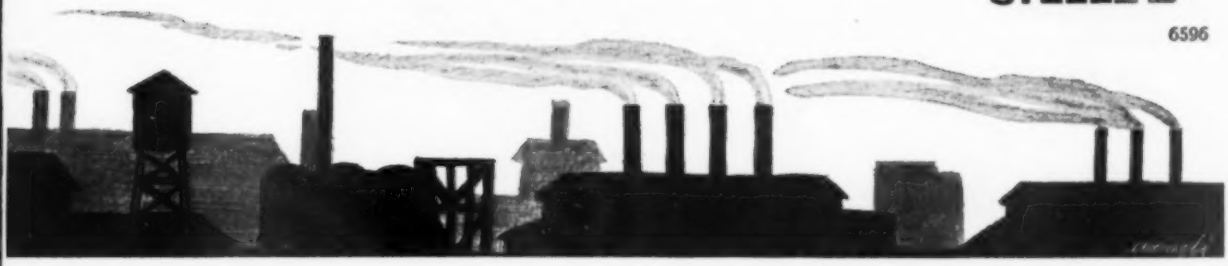
Automotive Wire Products • Baling Wire and Ties • Barbed Wire • Belts—Woven Wire Processing • Bridge Products Chemicals and Coke • Door Hardware (Garage, Overhead, Sliding, Fire Door) • Electrical Wire and Cable • Fabricated Steel Plate Products • Fence, Chain Link, V-Mesh, Woven Wire, Ornamental • Fence Posts • Fence Stays • Flower Bed Border • Gates • Galvanized Steel Strand • General Purpose Welded Wire Fabric • Grader Blades and other Cutting Edges • Grinding Balls • Grinding Rods • Grizzly Bars • Hardware Cloth • Industrial Wire Cloth • Insect Wire Screening Mine Rails and Accessories • Nails, Staples and Spikes • Nettings—Poultry, Stucco, Fish Trap • Overhead Conveyor Systems • Pig Iron • Pipe—API Large Diameter • Rails and Accessories, Standard • Reinforcing Bars and Tie Wire Rock Bolts and Metallic Fabric • Screen, Woven Wire, Industrial, Space, Vibrating • Seamless API Casing and Tubing Semi-Finished and Hot Rolled Carbon Steel • Springs and Formed Wire • Spun and Pressed Heads and Fittings • Steel Plates—Carbon, Alloy, Stainless-Clad, Nickel Plated • Strand and Wire—Prestressed Concrete • Welded Steel Plate Girders Welded Wire Reinforcing Fabric • Wire (All Types) • Wire Rope • Wire Rope Slings • Wire Rods

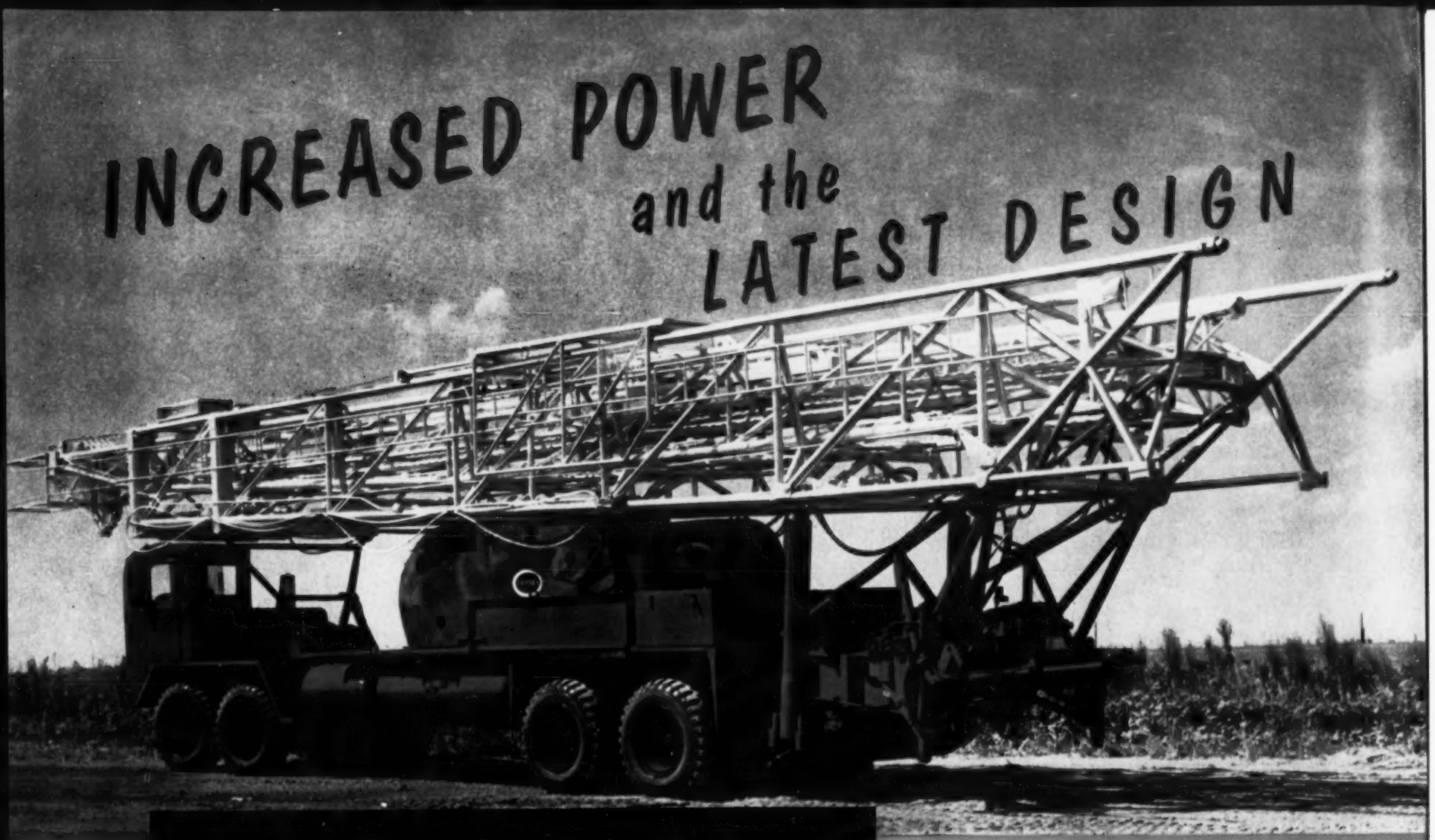
THE COLORADO FUEL AND IRON CORPORATION

DENVER • OAKLAND • NEW YORK

CF&I STEEL

6596





LEADING SERVICING AND WORKOVER
MEN IN YOUR AREA

FRANKS EXPLORER

. . . WILL TELL YOU THAT TO MEET THE INCREASING DEMANDS OF SERVICING AND WORKOVER TODAY IT TAKES EQUIPMENT LIKE THE FRANKS EXPLORER TO DO THE JOB.

THEY'RE OUTSELLING OLDER DESIGN UNITS.

TO GIVE BETTER SERVICE USE FRANKS

TO GET BETTER SERVICE USE FRANKS

EASY UP!
EASY DOWN!

EXPLORER FEATURES

NEW HARDENED, REMOVABLE FLOATING BRAKE RIMS.
NEW CONTROLS for easier, faster, safer handling.
ALL MODELS AVAILABLE WITH TORQUE CONVERTERS.
INDUSTRIAL ENGINE — Waukesha, Cummins, G.M. or equivalent up to 400 H.P.
NEW MAIN DRUM DESIGN for fastest, safest pulling.
NEW WATER AND AIR COOLING BRAKE SYSTEM. (Pat. applied for.)

WELL SERVICING AND DRILLING UNITS

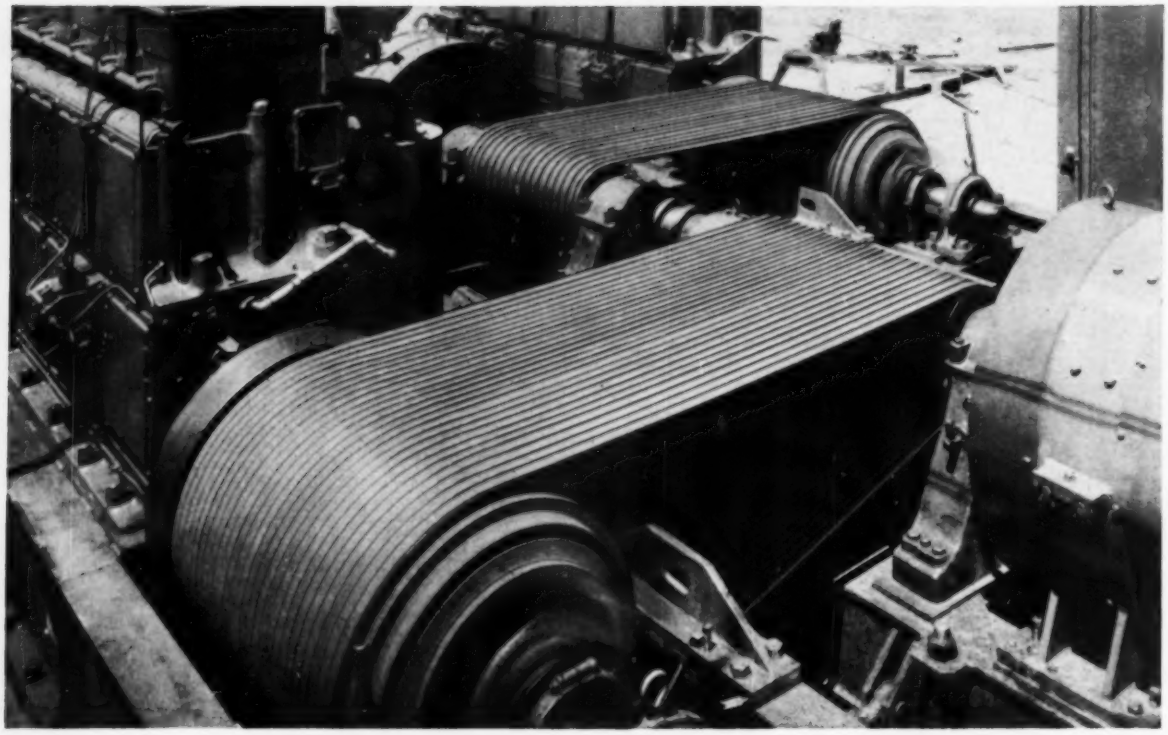
FRANKS

DIVISION OF CABOT

PAMPA, TEXAS

SEE OUR EXHIBIT AT INTERNATIONAL PETROLEUM EXPOSITION, MAY 14-23, TULSA, OKLAHOMA

Cut downtime out of drilling costs with Multi-Matched Dayton V-Belts



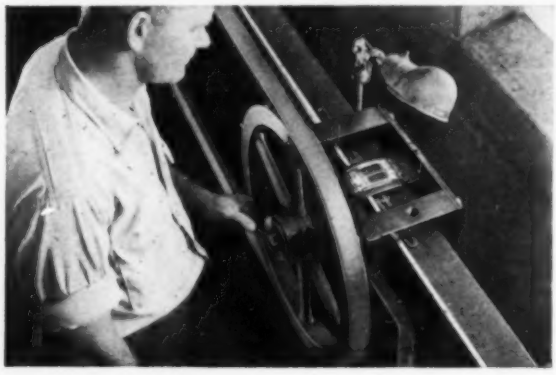
Nowadays, it seems you have to set a drilling record to make a profit. Margins are so slim that a single equipment failure can wipe it out.

That's why more and more drillers are specifying Dayton Multi-Matched V-Belts. They just can't afford to take chances with anything less. One fast-moving Tool Pusher has been using Multi-Matched Dayton V-Belts for about 8 months. But in that time, he's drilled 12 holes and a total of 96,000 feet without a minute's stop for V-Belt maintenance.

Multi-Matching makes the difference. For it insures that each belt in the set is pulling no more or no less than its share of the load. Actually, a set of Dayton V-Belts is matched a total of 5 times . . . twice at the factory . . . twice again in the field . . . and finally just before they're delivered to you.

Make sure you aren't adding downtime to your drilling costs — insist on Multi-Matched Dayton V-Belts. They're available at over 100 oil field supply points.

Every set of Dayton Thorobred V-Belts is Multi-Matched on precision motor-driven Matchometers, the finest device made for matching V-Belts, built exclusively for The Dayton Rubber Company.



Dayton Rubber

World's Largest Manufacturer of V-Belts

1859 1959

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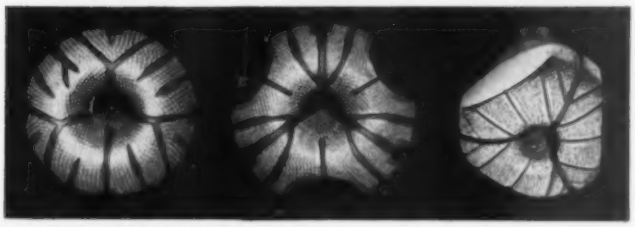

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Spearheaded by D&S–TRUCO

During the past 10 years many new principles have evolved to change the design and performance of diamond drilling and coring bits. Through this era the industry has looked to D&S for leadership.

With the introduction of the now famous TRI-DIA bits, D&S scored a major industry advance. Now, through research D&S brings you the all new TRI-Y jet action diamond drill bit . . . custom designed to give faster penetration, eliminate re-grinding center, last longer and give more overall rig savings.

WRITE OR CALL TODAY! Your D&S sales engineers will call on you and explain this revolutionary new Diamond Bit.

TRI-Y Standard recommended for extremely hard abrasive formations. Reduced Face TRI-Y recommended for sands, shales under pressure compaction.

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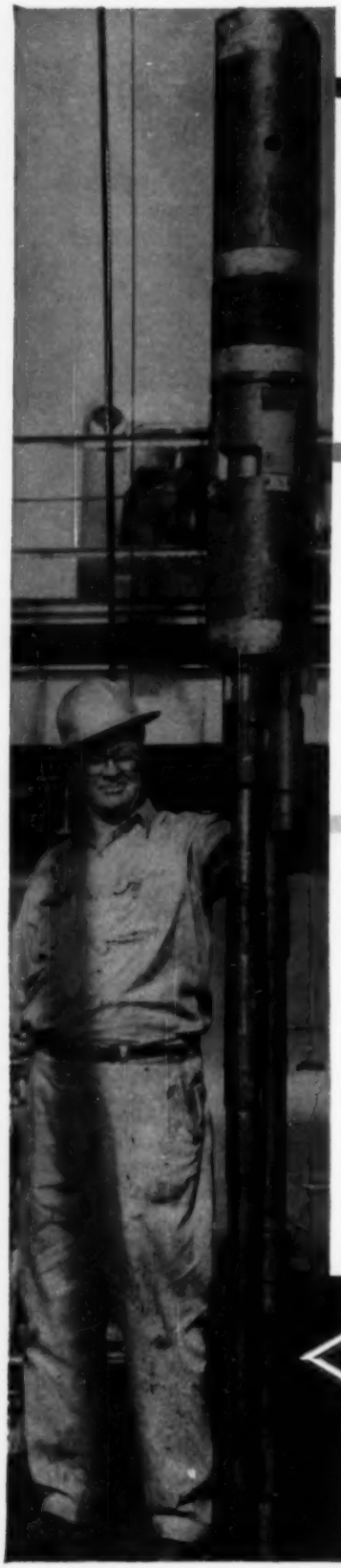

Any way you look at it--

TRIPLE STRING

completions are rewarding to the operator. With today's advanced tools, production and completion operations are entirely safe. Each year brings improved equipment and techniques, such as the fully retrievable hydraulic-set packers now available.

TRIPLE STRING

completions can be made at very little additional cost. After all, it's a matter of pure economics. Fewer wells need be drilled and payout is faster. P·R·I·M·E® completions have operational advantages due to flexibility of down-hole arrangements.

TRIPLE STRING

completion equipment was developed by Brown Oil Tools—and don't forget, Brown can supply your needs for single, dual and quadruple string installations.

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P·R·I·M·E® — (Parallel Retrievable Independent Multiple-string Equipment)

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Here's the answer for a truly efficient, all-purpose bridge plug – one so simply constructed, with no moving parts, that it will not fail mechanically – so positive in sealing action that you get a leak-proof seal under hydrostatic pressures as high as 13,000 psi – yet so versatile it will successfully accomplish the most difficult plugging operations as well as the easiest.

The McCullough Bridge Plug is an explosive-expansion plug made of drillable aluminum. It is set at the desired location by the power of expanding gases from within the plug. On permanent installations it will last as long as the pipe in which it is set. It is ideal for temporary plugging operations as it drills out quickly and easily with a rotary bit.

TAKE A LOOK AT THESE FEATURES

- Simple, one-piece, all-aluminum construction. Slips, reins, rubber packers and all hardened or moving parts that might impede drilling out have been eliminated.
- No slips to hang up or accidentally trip and set the plug while going in the hole.
- Makes a positive leak-proof seal under the heaviest hydrostatic or mechanical loads.
- Easier on the pipe than a slip-type plug.
- Because it's shorter and smaller in diameter it easily passes through tight spots, dog legs, etc., and saves rig time in running, locating and setting.
- Drills out easier and faster.
- Resists corrosion and electrolysis.
- Available in 37 sizes from 1¾" OD to 10½" OD for tubing, drill pipe, casing and in open hole in hard formations.

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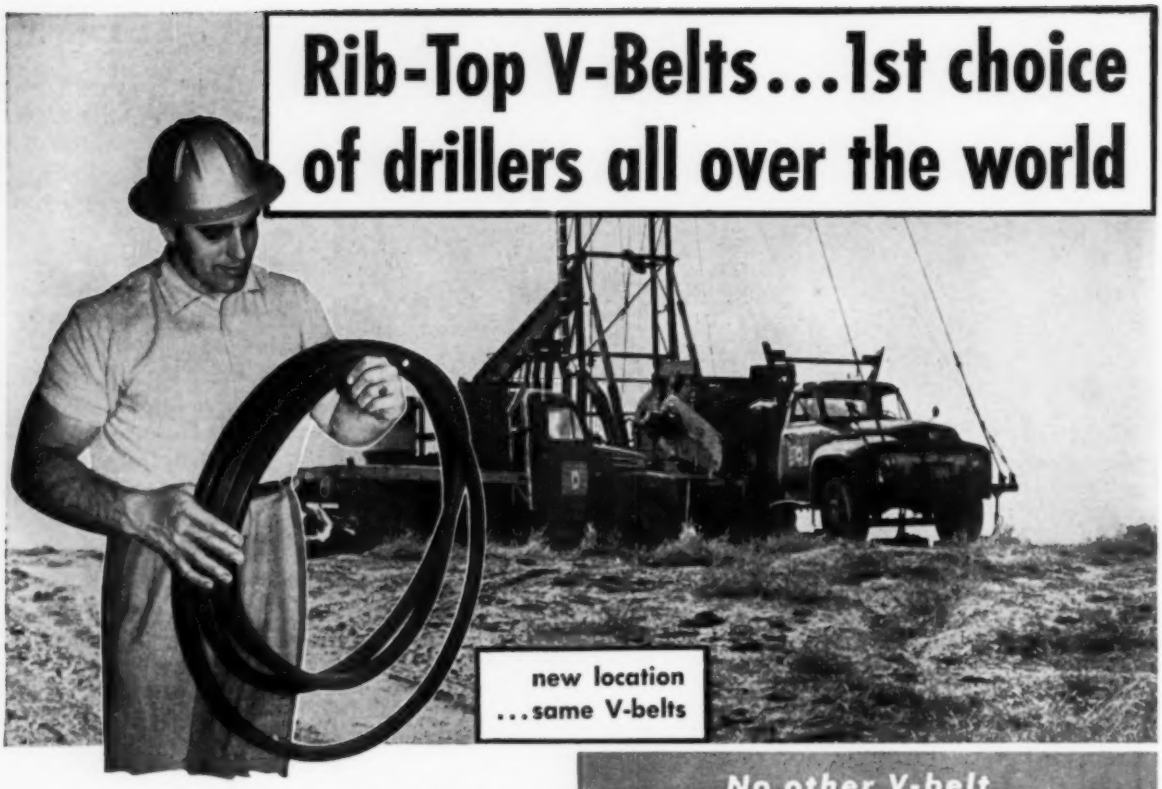
Rib-Top V-Belts...1st choice of drillers all over the world



Gates Rib-Tops are the ONLY V-belts designed specifically for mud pumps. Specialized design and construction provide longer life, minimize down-time, and thus lower belt replacement costs.

Yet Rib-Tops cost no more than ordinary belts of comparable ratings.

Both Standard and Super Rib-Tops are available at your oil field supply house.

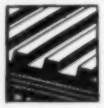
For Your Tougher Drives Use *Super* Rib-Tops!

With 40% greater horsepower capacity, Super Rib-Tops handle overloads easily. Fewer belts and narrower sheaves solve space and weight problems.

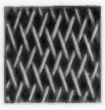
The Gates Rubber Company
Denver, Colorado

The Mark of Gates *Specialized* Research

No other V-belt has ALL these advantages

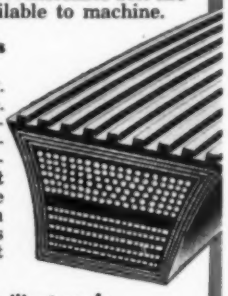


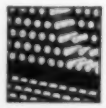
1. Stabilizing ribbed tops (U.S. Pat. 2548135) are exclusive with Gates. They dampen vibration, protect top of belt from damage, keep belt running smoothly over idler-equipped mud pump drives with no side whip.



2. Flex-Weave Cover (U.S. Pat. 2319590) A Gates exclusive: provides greater flexibility with far less stress on fabric. Cover wears longer ... increases belt life ... more power available to machine.

3. Concave sidewalls (U.S. Pat. 1813698) Concave sides (Fig. 1) increase belt life. As belt bends, concave sidewalls become straight, making uniform contact with sheave groove (Fig. 1-A). Uniform contact means less wear on sides of belt ... longer belt life.





4. Tougher, more resilient cords are able to absorb the severe pulsations of mud pumps; easily handle peak loads.

TPA393

Gates Rib-Top Vulco Rope

DEVELOPED ESPECIALLY FOR MUD PUMP DRIVES

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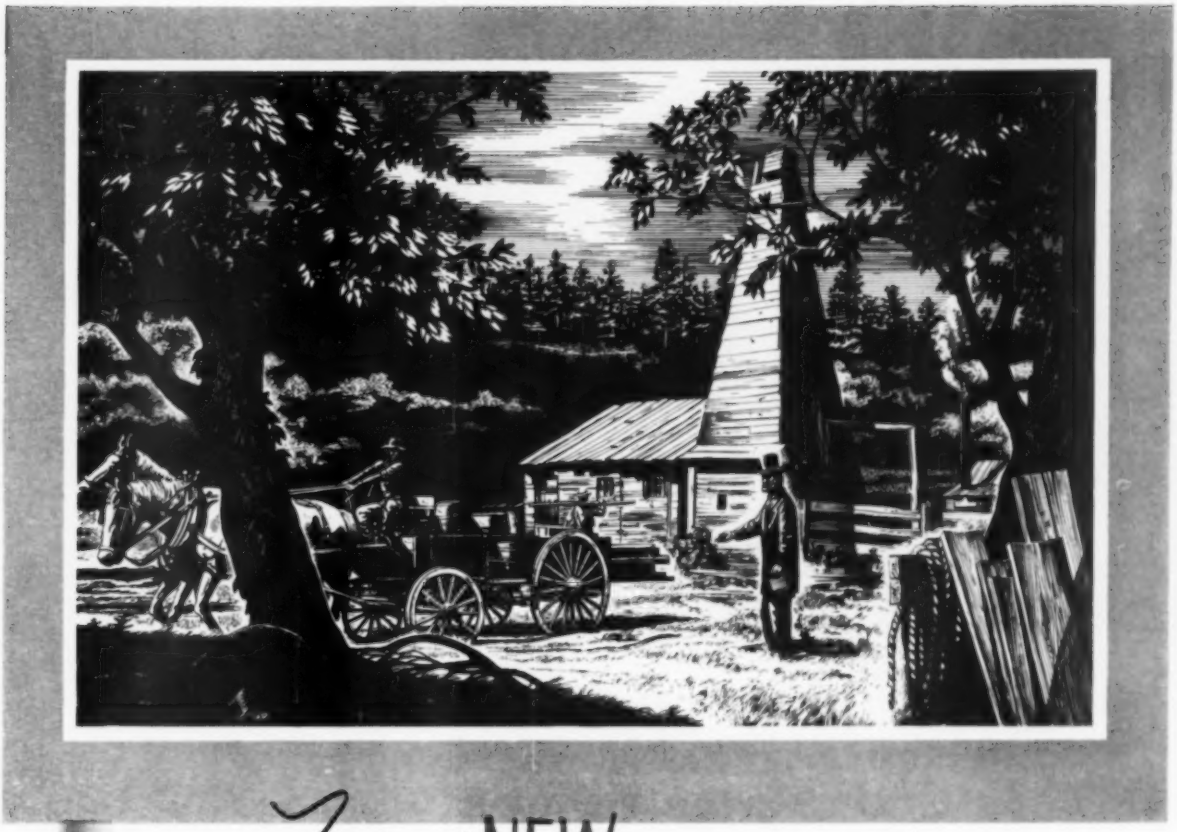


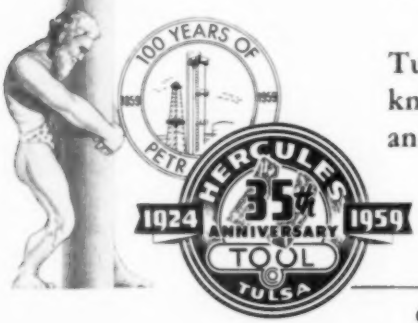
What's NEW in oil production

Visit Our Booth, Spaces 7, 8 and 9, California Building May 14-23, 1959 During the **International Petroleum Exposition.**

Back in 1859 and for the next sixty years oil production was pretty much mud, mules and muscle. The mud, in those days, was not in the wells but in the fields and it took all the muscle and mules obtainable just to get to the well.

Following this was an era of well blow-outs and fires resulting in the loss of many lives and millions of barrels of crude. These were everyday occurrences in the industry when Hercules Tool Company entered the business in 1924.

Today, on wells using Hercules Casing Heads, Tubing Heads and Stuffing Boxes, blow-outs are unknown. Use Hercules Well Heads for Safety, Economy and Ease of handling.



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For Today's Drilling..

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OUTPERFORM them all

Continental-Emsco "D" Series Pumps have proven themselves on drilling locations the world over.. proven they are heavy enough to handle the volumes and pressures demanded by modern drilling.. yet light enough to save you money in transportation costs and rig-up time.

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More *proven* advantages are yours with Continental-Emsco Slush Pumps.. get all the facts about big performance.. low weight "D" Series Pumps.

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SP 804

For Dual String Completions – Flowing or Pumping

Use GUIBERSON'S RETRIEVABLE TYPE RD PACKER

Type RD Packer with Anchor and Plain Stinger

This cleanly designed, rugged packer is an outstanding Guiberson development for dual string installations in wells of any depth.

Outstanding in performance because it operates perfectly with both zones flowing, high or low differential pressure; with either zone flowing, the other zone pumping; with both zones pumping; with either or both zones on gas lift; or for multi-zone injection — gas or water.

Outstanding in advantages because it completely isolates each zone from the other and from the casing; provides full opening long string to lower zone; permits either string to be pulled or run separately.

Guiberson's RD packer does complex dual zone jobs so well that operators tell us it's their best investment for dual string production. Ask your Guiberson representative about installation and auxiliary equipment recommendations.

Guiberson's RD packer has smooth operating dovetail slips of heat-treated alloy steel. Packing rubber is one-piece sleeve type — will not vulcanize in the well, made of Guiberson's special oil and gas resistant compound. You can get the RD packer with or without anchor, and a choice of stingers, plain or with snap-ring. Piston slips have extra large gripping area, are heat-treated alloy steel and keyed to anchor body up to maintain proper alignment. Get the Best — Get Guiberson.

THE GUIBERSON CORPORATION

ESTABLISHED 1919
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Sold by Oil Field Supply Stores

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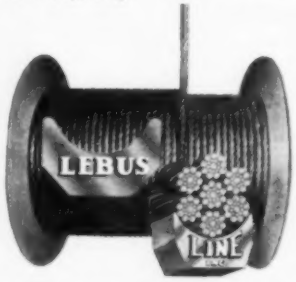
LEBUS SPOOLING

FOR ALL TYPES OF HOISTING UNITS

In addition to the standard grooved segments, LeBus provides a complete stock of Machine Grooved Split Adapter Sleeves for all sizes up to 2½" line and to fit up to a 36" "Drum" core for quick installation anywhere. This grooving is ideal for many types of drum grooving. For example, units already in operation requiring a line size change can quickly be converted with LeBus Split Adapter Sleeves. If two different size lines are used a removable sleeve can be installed. The LeBus Split Adapter Sleeve Grooving installation is flexible to meet any situation and may be easily and expertly bolted or welded by any good mechanic. Write today for complete details . . . enjoy trouble-free spooling this fast, easy way!

The above pictures a mechanic preparing to fit the second half of a machine grooved Split Sleeve or adapter for drilling and bolting. A Split Sleeve can be more easily welded. These installations can be made in factory, storage yard or on the job where hoist is operating.



LEBUS INTERNATIONAL ENGINEERS, INC.
LONGVIEW, TEXAS

LEBUS...WORLD HEADQUARTERS FOR *Engineered Spooling* COUNTERBALANCE - PYRAMID - HELICAL

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THE NEW

LUFKIN

AIR BALANCED UNIT

features **FACTORY LUBRICATED BEARINGS** *throughout!*

Husky, oversize SEALED bearings require NO field lubrication

ASME CODE AIR TANK COMPLIES WITH ALL STATE SAFETY LAWS. PATENTED SEALING ARRANGEMENT INSURES NO LOSS OF AIR.

EXTRA HEAVY STRUCTURE FOR SURPLUS STRENGTH AND RIGIDITY.

ROTARY TWO-STAGE COMPRESSOR FOR AIR MAKE-UP WITH SIMPLE FOOL PROOF COUNTERBALANCE ADJUSTMENT.

LUFKIN PRECISION GEARS, SO WELL KNOWN FOR DEPENDABILITY AND LONG LIFE.

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Eliminate *high-pressure surges...*
Fill *your casing automatically...and*
Circulate *at any time while running-in with*

BAKER
CIRCULATING
FLEXIFLOW

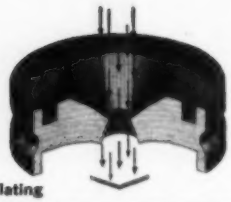

Fig. 1 — Circulating

Fig. 2 — Filling Casing

Now, not only can you fill casing automatically from the bottom while running-in, and protect low-pressure, permeable zones from damaging pressure surges – but you can also *circulate at any time.*

Baker "Circulating" FLEXIFLOW Fill-Up Collars feature a self-adjusting Flow Control Diaphragm that opens up (see Fig. 2) to relieve destructive pressure surges – as high as 5,000 psi – which tend to build up when casing equipped with conventional floating equipment is lowered in open hole. And then, when the rate of lowering is slowed down and pressure from below is reduced, this Flow Control Diaphragm closes down to prevent overfilling; see Fig. 3.

That's why Baker FLEXIFLOW Collars help prevent costly circulation losses . . . reduce mudding-off of producing zones . . . permit maximum recovery . . . and eliminate fracturing as a cause of primary cementing failure.

Surface filling is completely eliminated. Your casing fills *automatically* from the bottom *as it is run.* You can keep the casing moving, except for the short interval required to add and make up a joint.

In addition, you can *circulate at any time* while running-in. And a back-pressure valve can be brought into action for cementing by merely pumping a Bakelite Ball down the casing to the Collar; see Fig. 4.

Ask your Baker service engineer for more information about the successful Baker "Circulating" FLEXIFLOW Fill-Up Collar, and its companion, the Baker Model "E" Triplex Cementing Shoe, Product No. 136-E—a perfect-combination for many "problem" cementing jobs.

Fig. 4— Back-pressure ball dropped and pumped through hole in diaphragm.

Fig. 5— Ball in position to provide back-pressure valve.

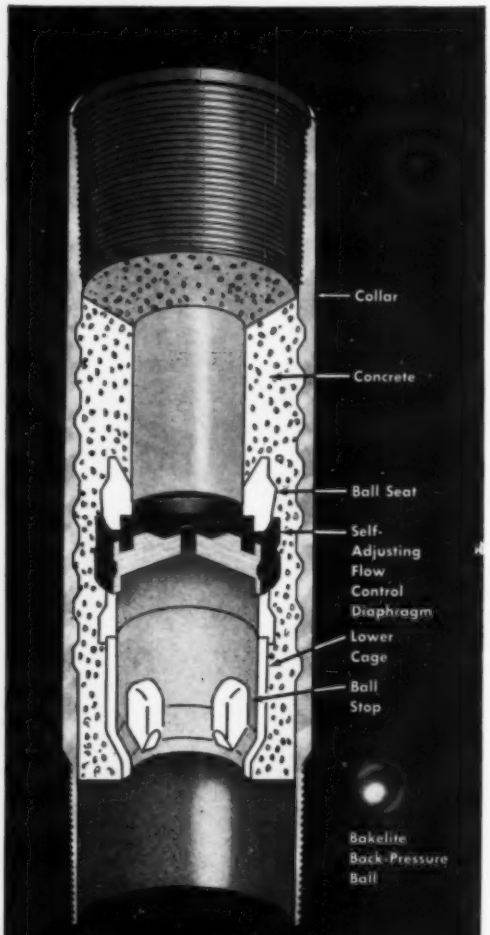

Fig. 3—Baker Model "D" Circulating FLEXIFLOW FILL-UP Collar, Product No. 161-D M&F

BAKER OIL TOOLS, INC.
HOUSTON/LOS ANGELES/NEW YORK

BAKER

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THE ATLANTIC LECTURES OF THE UNIVERSITY OF TEXAS

PART 6

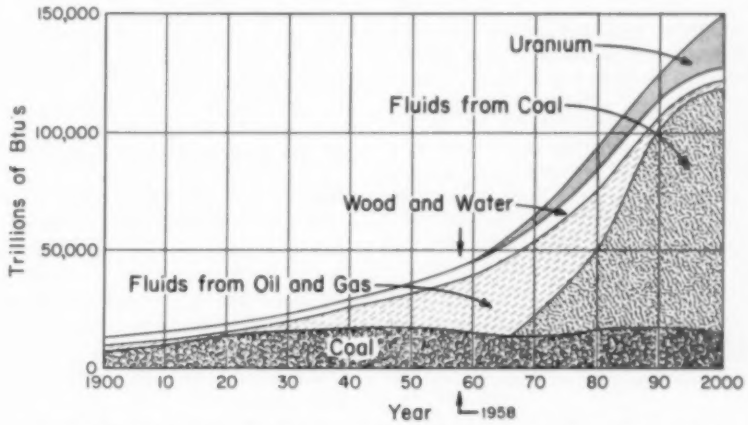
DRILLING FOR OIL In 1975

During the next 15 years, the depth of U.S. oil wells will double . . . but the problems associated with drilling these wells will be multiplied many times. Today's engineers must lay the groundwork for the solution to many of these problems

R. O. Childers, *General Drilling Superintendent, Atlantic Refining Company, Dallas, Texas*

THE FUTURE PROSPERITY of the producer and refiner of liquid hydrocarbons depends on the ability to meet the economic competition for the energy markets of the world. As the search for oil progresses from the ocean to the mountains and from the desert to the artic, men have exercised their ingenuity to conquer the obstacles encountered, but to a large extent have failed to overcome the economic barriers slowly closing upon the industry.

The finding and producing costs of crude reserves will be determined by the drilling technology of the next 20 years. The drilling engineer of 1975 will exert a controlling influence on the wealth of the petroleum world.



—From "Bright Future for the Gas Industry" by Dr. Martin A. Elliott, director of the Institute of Gas Technology and Marvin Chandler, president of Northern Illinois Gas Company, presented at A.G.A. General Management Conference, Washington, D. C., 1958.

Future Energy Market

The graph (right) illustrates a concept presented to the American Gas Association in 1958. The presentation projects the energy requirements for the United States through the year 2000. Historically, the information can be certified but the projection from 1958 is a weighted estimate of the requirements and the sources expected to meet the national energy demand. Notice the increasing demand for refined petroleum products manufactured from vapor and liquid hydrocarbons for the next decade. At the close of that period other sources of energy invade the market, gradually supplementing the oil industry, if we are to follow the concept of the prophecy.

By about 1970, the critical period for maintenance of the industry we know will begin to affect the lives and professions of the men interested in the drilling and production of crude oil. The

graph (as most concepts) is predicated on the economic competition of alien sources producing energy for our national requirements. If the technical advances envisioned are realized, the petroleum industry's share of the energy market can be maintained at the maximum.

Recently, T. C. Frick, a member of the management of Atlantic Refining Company, remarked, "You can mark the year 1956 as the last year the new reserves of the continental oil fields of the United States were equal to the consumer demand. Beginning in 1957, our current reserve will fall short of the consumption rate in our country. We are on the way to being a 'have not' nation."

Practical drilling men are reaching for the 25,000-ft horizon with tools, equipment and technology designed for 15,000 to 17,000-ft drilling. Mechani-

cally and technically the industry is retarded by lack of economic technological developments to overcome the barriers now before us.

The forward look of world geology points to the exploration of the earth's crust to depths of 50,000 ft in search of raw materials to supply the energy demand for the next century.

Formerly, the exploration group found, surveyed, and purchased prospects with small regard for the operational problems inherent to the project. As wells pierced deeper and more difficult structures, the economic picture became more complex. The cost of development assumed the controlling position in the financial picture with the drilling phase being of primary significance. Drilling expenses have prevented the exploitation of many productive prospects that would have added considerable reserves to our national oil supply.

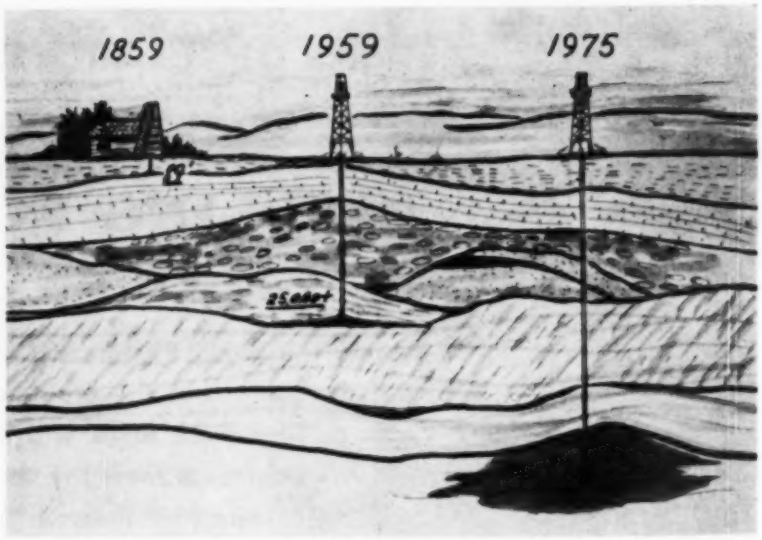
While it is healthy to respect well development costs, the popular pressure to limit or insure profits for high risk effort may well be the death of aggressive exploration in the United States. The federal income tax structures, through the depletion and intangible allowances, support a favorable atmosphere for exploration. On the other hand, in the race of depth versus reserves (see Table 1 and 2), we too often meet our problems with an outpouring of dollars, pacifying the deficit entry with the cry of "emergency" or "it's just tax dollars."

TABLE 1. Crude Oil Reserves Discovered per Foot of Hole Drilled.

Year	Oil Reserves Discovered per ft of Hole — bbl
1937-1941	28
1942-1946	25
1947	22
1948	28
1949	23
1950	16
1951	25
1952	14
1953	17
1954	14
1955	13
1956	13

TABLE 2. Gas Reserves Discovered per Foot of Hole Drilled.

Year	Gas Reserves Discovered per ft of Hole — MMcf
1946	0.18
1947	0.10
1948	0.10
1949	0.09
1950	0.08
1951	0.09
1952	0.08
1953	0.10
1954	0.05
1955	0.10
1956	0.09



Perhaps the economic alarms of 1958 will exert a healthy and invigorating influence on the oil well drilling industry, inciting us to begin what we should have already done. Namely, to face our problems with open, active and trained minds, resolved to create new methods and techniques to meet the competition of the atomic world.

Mechanical Developments

What are the mechanical problems facing the industry? Do you remember the fable "Pandora's Box?" Pandora's troubles were no more multitudinous than those plaguing an operation as it first reaches beyond 17,000 ft and, like Pandora, once the box is opened we cannot close it but must live with the consequences. Generally, the problems involve mechanical, hydraulic, chemical, and educational difficulties.

Our mechanical needs are:

1. Steel, sized and designed to meet the testing of the extreme pressures and stresses of deep drilling; sized to afford the use of drilling, completion, and lifting equipment for the recovery of the maximum of reserves found; designed to resist corrosion, embrittlement, pressures exceeding 30,000 psi, tensile stresses greater than 210,000 psi and collapse pressure possibly as high as 40,000 to 50,000 psi. (See Table 3.) The basic design of the joint coupling must be altered to withstand stresses equal to the pipe body effectively joining against stress and leakage. The present coupling design necessitates testing at every step of the installation, resulting in eco-

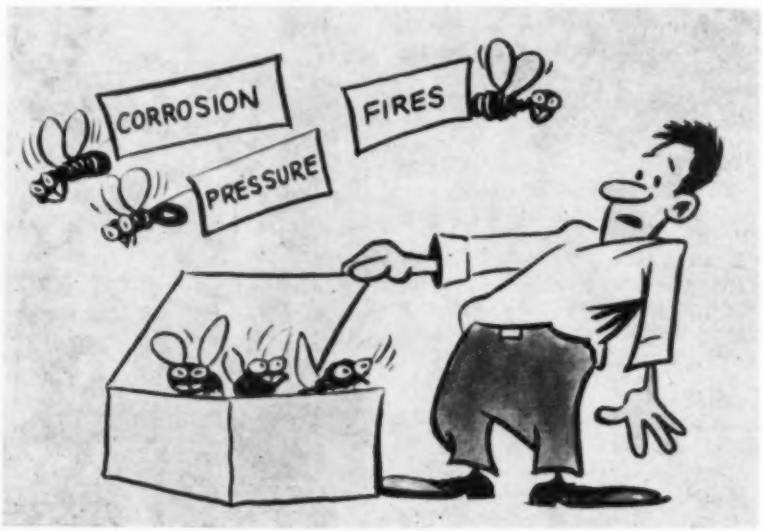


TABLE 3. Limitations of 5-in. OD Casing.

Grade	Tensile Strength — psi	Weight per ft — lb	Depth Limit — ft	Total Load — lb
J-55	55,000	15	16,470	247,000
N-80	80,000	18	19,670	354,000
P-110	110,000	18	25,720	463,000
P-150	150,000	18	35,000	525,000
?	210,000	18	52,500	900,000

nomic and operating time losses intolerable to operation.

2. Plastics or compositions for use in packing, sealing and conducting, capable of withstanding pressures and temperatures 50 percent greater than the steel used in the tools.
3. Steel valves capable of withstanding 50,000 psi working pressure that will still seal after many cycles of use.
4. Wellhead and casing supports to support gross loads of 3,000,000 psi and safely contain the pressures encountered.
5. Hoisting equipment to move 10 miles of pipe safely in a single operation.
6. Mast and structures to support such equipment.
7. Pumps to operate at 15,000 to 18,000 psi while drilling — that is, if we still drill with present day methods.
8. Bits or drilling mechanism to operate at extreme depths and temperatures. Temperatures may be as high as 1000 F at 50,000 ft. Temperatures above 400 F have been found at 17,000 ft.
9. Packaged power for equipment —possibly more than 5000 hp — for rig operation.
10. Methods and tools to effect round trips in six to eight hours when necessary.

The items enumerated are necessary to the mechanical operation of a well drilled below 50,000 ft. I do not attempt to visualize the hoisting equipment that will be developed. It is believed that the equipment of today will be completely obsolete with its inherent problems and replaced by a hydraulic, actuated hoisting mechanism similar to a huge tripod jack.

The physical problem of storing casing or drill pipe on a trip to 50,000 ft would certainly be one of major proportion. It is possible that we would not 'trip' the drill pipe after reaching a depth of some 30,000 to 35,000 ft, but would depend on retrievable bits and drill mechanisms that could replace the cutting head at the bottom of the hole without pulling the casing or drilling string.

Some of these things are visionary—some of them are actually in the process of development today. We speak of cutting mechanisms, rather than bits. The Russians have announced studies novel to present equipment. As we know, the Russians have been very forward in their statements but their performance in areas other than the petroleum field indicates that they speak before they act, but they do have some basis for their statements.

To explore and exploit the areas from the Mississippi Delta to the border of Mexico and along the seaboard areas of the United States to a depth of 50 to 100 miles seaward, will require an estimated 1000 holes or 10 million ft of hole annually between now and 1965, increasing to 1300 wells per year by 1970. If the geological prognoses are correct, this would increase continental gas reserves 70 percent and oil reserve 30 percent. Herein lies a challenge to the imagination and ingenuity of the engineer of 1958.

To date we have not been able to exploit, in the proper sense of the word, the reserves that are known to lie in the region designated as "offshore." To exploit those reserves will require either a major economic revolution that would put the use of petroleum products beyond the average American's ability to pay, or a major development of a mechanical nature.

We know, with reasonable certainty, that huge reserves are to be found in regions inaccessible to present equipment — inaccessible due to the economical wilderness that has grown up around our efforts to exploit those reserves. These problems must be overcome to maintain a satisfactory power reserve and it is axiomatic that the solution will be mechanical.

We have looked casually at some of the aspects of the mechanical requirements for the equipment we will need to exploit and develop our future prospects, but there are other needs today that are even less attended than the mechanical ones.

In the electrical field, progress has been rapid. We have been dilatory in adapting electrical innovations to aid drilling techniques. Drilling is literally starving for electronic assistance.

Straight hole conditions are established by the same methods originally conceived by the people that put together the first rotary rig.

We have made a few major advances since 1945 in logging techniques.

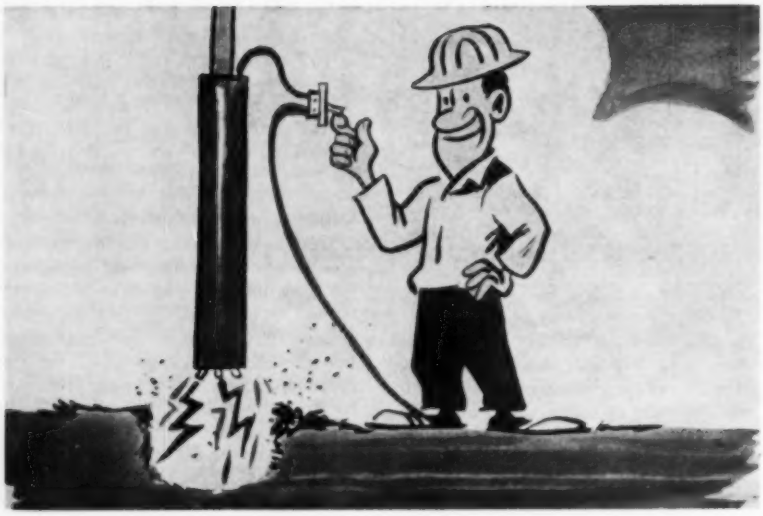
We are doing a noble job in supplementing present methods but we will need new ways to determine the nature and condition of the strata penetrated when we drill beyond 30,000 ft.

Logging at 50,000 ft

Insulation for electrical instruments, condensers, electrodes and containers for these items will be subjected to the highest temperatures and pressures conceivable. Perhaps the solution to this problem will be found in the mechanical field, but the problem needs to be defined and the specifications advanced so that the metallurgical and chemical engineers working with the problem will know the conditions and abuses the equipment they design must stand.

When exposed to extreme temperature or pressure, the characteristics of our most durable metals undergo drastic changes. The plastics and insulation materials of the more sensitive type are even more susceptible to changes of environment. The present electrical and radiation surveys are extremely susceptible to temperature variations, mechanically and operationally. The effect of thermal conditions of the physical area being logged usually alter the recorded data so that even the most comprehensive interpretation is hardly more than shadow zone quality. The physical problems of running instruments now used in extremely deep, hot wells are so great that we are reaching the limit of wireline logging.

Under discussion throughout the industry and a desirable goal is a logging instrument that will currently report the formation being drilled at the bit, and also furnish pertinent information for engineering and geological



analyses. With the new developments in the electronic field, such an instrument should be in use within five years, but you can readily appreciate the terrific problems designers are encountering in regard to pressure and temperature when compounded by the vibration of continuous pump and bit action at the bottom of the hole.

When the electrical engineer, and perhaps chemist, meet the problems discussed above, a new field will be open to drilling techniques. With properly designed tools, we could drill with sonic or the electrical technique.

Present Techniques Inadequate

In this country, of course, we have under study several types of turbines and turbine bits that are nothing more than adaptations supplementing our present techniques. Somehow or other, while attractive for the short term drilling outlook, these techniques do not reach far enough ahead to carry us into drilling depths visualized for 1975.

The deepest well drilled today, 25,000 ft, cost about $140 per ft. This cost, when compared to a 10,000 to 12,000 ft hole at $14 per ft, generates an expense curve that could be extrapolated utilizing present techniques to a depth of some 50,000 ft. The extrapolation quickly certifies that such wells cannot be drilled to compete in the energy market. For that reason, and that reason alone, I would justify the statement "the adaptation and supplementing of present techniques will only meet our problems for the short term future and cannot be expected to satisfy the long range needs of the drilling industry."

We have to this point looked at some of the mechanical and electrical problems encountered in drilling a well to 50,000 ft. Our government recognizes the problems we are facing and there seems to be a movement under way to afford some support of the overall research to meet the problems. The assistance of a government-regulated research group in meeting the problems we expect to encounter may be the answer if we sit idle and allow nations and peoples living under a different ideology to overrun our world position. I like to believe vigorous competition of free enterprise will preclude this approach, but rather doubt that we could justify objections to the entrance of a government agency into research fields if we fail in vigor or imagination.

As we delve into the problems involved in drilling a deep well, the techniques begin to involve production, stimulation and maintenance. Many of the problems mentioned were concerned with the design of the metals and materials required for the completion and control of a deep oil well. Since we have only meager knowledge of the control and inhibition of the destructive forces unleashed during the production of high-pressure, high-temperature hydrocarbons, our fundamental research must face the problem of maintaining the chemical and structural properties of the metal with limited experience.

Hydrogen invasion of metal structures is the major problem being encountered in high-pressure wells today. Can metallic structures be made—and here I would almost use the word "created" — that will resist this insidious attack? To date this problem has been met by inhibition, isolation, and adaptation of special metals to the problem. The first two items are very clearly stop-gap procedures, since once installed they are sensitive to errors in application or damage. The third method, apparently along the pathway to the correct procedure, has resulted in some extremely difficult problems concerning the ductility of the metals. You may recognize this problem from some of the expensive and wasteful wild well control problems encountered across the Gulf Coast and in West Texas.

High Cost of Inspection

Through all of this discussion we have talked of many things, but the system of inspection has not once been mentioned. Recently, we reviewed the cost of inspection of tubular goods for use on a high-pressure 15,000-ft hole in the Louisiana Gulf Coast. The inspection alone, excluding handling charges and delay, costs approximately $11,500. The justification for this expenditure could be the rejection of one dangerous joint of casing or tubing, but when 199 wells were drilled below 15,000-ft in one year, the inspection bill for the casing and tubing represented a big share of the capital investment in the drilling projects. Little return can be expected on this investment other than peace of mind and safe operations.

The procedure followed for tubular goods today is multiple inspections for the various types of defects and failures that are found in newly manufactured goods that have passed a hydrostatic and mill inspection. Tubular goods for high-pressure, deep installations usually follow the following test pattern:

1. Close control of the metal structure and its mechanical properties until the steel is rolled into

Mr. Childers *was born in Walters, Oklahoma, October 23, 1914, and was educated in the public grade schools of Stephens County, Oklahoma. He graduated from high school in Holliday, Texas, in 1931 and attended Oklahoma University for a short time.*

He has been employed with Halliburton Oil Well Cementing Company, Baker Oil Tools, Superior Oil Company of California, Noble Drilling Company and American Seismograph Corporation.

Mr. Childers began his employment with The Atlantic Refining Company in October 1948 in the capacity of regional drilling supervisor in Tulsa, Oklahoma. In April of 1954 he was promoted to general drilling superintendent, headquarters in the Dallas offices.

billets. Most of this work is supervised by the steel mills but usually in a critical situation an additional inspection is required to substantiate the chemical properties of the metal.

2. Physical inspection of the billet for visible defects.
3. Once the tube is formed and prepared for threading, a close inspection by magnaflux and hardness testing is required to determine that no flaws or defects have developed in processing.
4. After threading, hydrostatic and tensile testing to 87½ percent of the calculated strength of the tube is necessary.
5. Before running the casing or tubing, a tensile test is required to determine that no unusual stresses in shipment have been put on the tube that may reduce its value.
6. After the tube joint is made up in the derrick, a pressure test of the joint is made to determine that it is satisfactorily jointed and does not leak at extreme pressures.

The expense of this procedure is obvious and its time-consuming awkwardness results in increased hazard to the success of the effort. Hence, a rapid, economic inspection of tubular goods that is foolproof is needed. We should establish an API technique for testing casing that will be used at near its maximum value.

The present use of threaded joints to join casing depends largely on a metal-to-metal seal. For the present this is adequate. For the future, the high-temperature high-tensile loads imposed on the joints joining the tubes will result in leakage beyond that found today.

Some work has already been accomplished in the manufacture of a joining compound which would set under the extreme pressures imposed as the joint is made up and, once set, would not yield to the temperatures expected in the well bore. If such a procedure is followed, a different method will have to be found for the release of the joints if they are pulled from the well.

So, as in many things, the solution to one problem will probably generate another, and another. The short-range outlook of the solution of the problem will not be acceptable when involving the investment of millions of dollars, but the whole problem must be solved before we can gain acceptance of a new procedure, even though we need it very badly.

We have mentioned the problem of supporting gross casing loads of 1500 tons at the surface of the ground. There are many methods employed to gain support around the wellhead to avoid column failure in the casing string as it is set in the hanger. Some designs call for large bearing surfaces, spiders, or well yokes set on larger strings of casing of heavy wall strength cemented to the surface. Other designs call for the release of weight in the casing string against the cement column, thus securing the casing from column failure by imposing the stress on the frozen portion of the string. The problem is structural and will be easily solved, but it is one that the drilling engineer prepares to answer as he plans the casing of deep wells.

Miracle Muds Will Emerge

One of the most intriguing problems in present drilling mechanisms is the design of a drilling mud for deep wells. There are two extremes to this problem: (1) The deep, hot well where the high temperatures and pressures encountered require the use of heavy weighted slurries for drilling; and (2) the deep, low temperature well that encounters sub-normal pressures requiring low weighted slurries for drilling. The solution to these problems probably does not lie in a common field, although the colloidal studies of the chemical engineer will cover both areas.

Presently, our deep, high-temperature, high-weighted mud programs for deep wells are designed with a water base and, through the addition of barites, clays, chemicals, and oils, a drilling mud is produced. A slurry weighing 18.3 lb per gal on a recent 17,000-ft hole with chemical treatment to reduce water loss, maintain pH and fluidity of the slurry, cost approximately $30 per bbl. The hole contained about 1200 bbl of mud and the surface pits an additional 1200 bbl, resulting in a circulating system costing about $75,000.

This mud cost does not seem excessive for a deep well but the attrition rate of about 5 percent daily due to drilling contamination resulted in a daily maintenance cost of $3000. To reduce the attrition rate while drilling, we have employed desander, degasser, and centrifuge clean-up methods. Although highly successful, this procedure is rather cumbersome.

Occasionally, zones of sub-normal pressure or fractures are encountered that absorb as much as the whole system contains before it can be controlled. This problem may be so drastic that it will be necessary to case off the zone before drilling can proceed or the well can be controlled.

Cost of drilling mud is an area that will allow for major research since the stakes on deep wells are great. Drilling men are impatiently waiting for the discovery of a high-weight liquid that is not so filled with solids that it slows the drilling rate. When enough weight, gel, and chemicals are added to a gallon of water to obtain a fluid of more than 18 lb per gal, the increased solids greatly slow the drilling action in the hole with present methods. If, for instance, we could start with a fluid weighing 15 lb per gal, the weight materials added would not compose a great volume of solids in the system and would help in maintaining a satisfactory drilling rate.

We could afford to pay $16 to $20 per bbl for a fluid weighing 15 lb per gal or more with flow characteristics near that of water. If the chemical characteristics of the fluid were properly designed, we could go even higher on our payments since it might be possible to reduce the chemical treatment required for water base mud now in use.

We have looked at one of the problems, now for the other problem — the deep, low temperature well with subnormal pressure and abnormal losses of muds or fluids to its porosity or fractures. Wells of this nature are more often found in West Texas, New Mexico, and the Rocky Mountain area, although they are not limited to these particular locations. The drilling mud in these areas should be a material that resists loss to the fractured, highly permeable porosity of sub-normal pressures.

The use of oil emulsions, soap emulsions, water-in-oil emulsions, and so on, have greatly reduced the weight of drilling materials used but have not successfully met the major problem of lost circulation. To combat that problem we are forced to use materials such as cellophane flakes, crushed walnut hulls, shredded automobile tires, wood and cane fiber. Most of this material is hard to remove on the completion of a well. We cannot estimate the extent of damage caused by its use and, of course, the use of this material is expensive since rig cost is added to the original cost of the material.

In low-pressure areas it is frequently necessary to combat intrusions of contaminated water that rapidly destroy drill pipe and bits. The presence of sulfates in mud due to this intrusion can reduce the life of in-hole equipment by 80 to 95 percent. If the walls of the hole could be conditioned to withstand muds of sufficient weight to contain those waters in the formation, the problem would be solved. Perhaps here would be a common plateau from which to work for the solution of the drilling fluid problems.

The solution has been proposed in several meetings and considerable work is being done by research and industry

to aid in realizing the benefits from the proposal. The problem is basically this: (1) To contain within its native horizon the fluids or gases that can be produced from the well bore; and (2) to so strengthen the incompetent section of the hole that it will support the weights necessary to accomplish this.

The present concept of drilling dictates the maintenance of a thin, impermeable filter cake on the wall of the hole to prevent the hydration of shale and minimize formation damage. This design seems to aggravate the problem of lost circulation due to fracturing. Since leakage of fluid through natural channels in the formation could, with time, strengthen the walls of the hole and make them more competent to bear the pressures imposed on them by the drilling fluid, the high water loss slug and soaking techniques have proved highly successful in many applications. These methods are rather tedious to apply but can be used in limited circumstances.

If it were possible to condition the walls of the hole as we drill to withstand pressures in excess of hydrostatic competence, we could drill much deeper with less casing, mud expense and with greater safety than we do at present. In the process of conditioning the walls of the hole, there are several things that should be taken into consideration:

1. Wall conditioning must afford the ready passage of drilling tools and casing.
2. Wall conditioning should be of such a nature that the formation can be restored to its original condition, since some day we expect to produce fluids from certain portions of the well bore.
3. Conditioning process should not affect formation characteristics in such a way as to prevent successful logging.
4. Fluid must be conducive to logging and should not exert destructive influences on the drilling strings.

These requirements under study seem to be a mass of contradictions. Perhaps that is one reason we have not been able to find a complete answer to the mud problem.

Mud and Cement in One Package?

Traditionally, we have cemented casing with a lime base slurry. We have successfully used the cement slurry to isolate the producing zone from adjacent water invasion. There are several limitations to the lime slurry. It is hard to control, difficult to mix, and responsive to some types of deterioration. The placement of lime cements have in some instances damaged producing horizons to a marked extent.

The cements of 1975, whether they are plastic, lime base, or converted muds, will have to meet exacting standards in every respect. There are occasions on which the cement would have to be of extremely light weight and occasions on which it would have to lend itself to extremely heavy weights. Thermal tolerance of the cementing material would be fantastic, ranging from subnormal to temperatures of 1000 F. Mixing and placing of the slurries would probably be the job of a chemical technician trained and experienced in the preparation and placement of the slurry.

If the circulating fluid used in the drilling of a well could be converted by the magic of the chemist's touch to a cementing material that is strong, reliable and easily placed, the "twin devils"—mud and cement—might be conquered. The chemist designing the drilling or circulating fluid for the well of 1975 may well be designing in the same step the final stages of the cementing, producing and plugging techniques for that well.

Production Stimulation

When we speak of the chemical field, our minds naturally turn to the prospects of stimulation of producing zones. Well bores are stimulated by two techniques—fracturing and leaching. The fracture technique has seen the use of dynamite, nitroglycerin and, of course, the use of hydraulic fracture methods of today. The last of these has been most important in our economic picture of 1958. In the tentative stages of introduction are several fracture tools pointing to the stimulation of thin zones near water production that may have wider application. It is difficult to describe briefly the techniques, but generally they could be called shock, sonic, vibratory and some may be classified as strictly explosive or expansive gas.

Recently, much discussion has been held in atomic research circles on the effect of major nuclear explosions in producing zones too tight for profitable production at this time. The recent explosion in Nevada indicates that there is some possibility in this direction. It is possible that production will be stimulated by nuclear blast and a continuing drive generated by the heating of the oil in the formation by the residual heat from the initial explosion.

The Rig of 1975

When the engineer of 1975 designs the actual drilling equipment associated with the successful completion of the 50,000-ft well, the prosaic problem of portability and transportation will plague him. Based on present operations, the rig to drill to 50,000 ft and its auxiliary equipment will weigh almost 2000 tons and usually must be transported to a remote area with truck load limits grossing approximately 60,000 lb. When the tare is deducted, a net load of 30,000 to 40,000 lb represents the maximum pay load transported.

Transportation of the rig and other materials and equipment will require, at the rate established above, approximately 345 loads, as follows:

Item	Weight lb.	Number of Loads
Rig complete	4,000,000	100
Mud and chemicals	2,500,000	65
Casing	5,100,000	130
Cement services	1,000,000	25
Miscellaneous	1,000,000	25
	13,600,000	345

Predictions are often based on the assumption that drilling designs in 1975 will approximate those of today. I believe that to be a false assumption for economic reasons alone. Finished machine steel used in oil machinery delivers at the rough estimate of 70 cents per lb. Converting these figures to dollars and summing up the total investment, the cost before considering risk and operation totals $5,185,000, as follows:

Item	Cost $ per lb	Investment
Rig, complete	70¢	$2,800,000
Mud and chemicals	15¢	375,000
Casing	30¢	1,530,000
Cement services	3¢	30,000
Miscellaneous	45¢	450,000
		$5,185,000

Recalling the share of the 1975 energy market predicted for oil and gas, this does not look very logical. Here then is the challenge. Can we meet competition for the energy market of 1975? Men with courage and vision in the beginning gambled their lives and fortunes to establish the oil industry. Can we, drawing on the reserves of knowledge and experience, create a new concept of operation able to maintain the pace set by the founders?

Recently, M. J. Rathbone, president of Standard Oil Company of New Jersey said, "One of the main roads leading to higher levels of efficiency is that of technical progress—not day-to-day routine engineering and research but rather, bold, imaginative and freshly creative research methods. By taking full advantage of the technical progress we have made so far and by rigorously pressing forward new frontiers of technical knowledge, the domestic producer can help open up a whole new and more profitable era."

★ ★ ★

Extensive field tests show that . . .

CMC Cuts Costly Packer Mud Problems

Use of a special gel-CMC mud as protective fluid above the packer between tubing and casing has resulted in considerable savings in workover operations

R. S. Baker
Drilling Specialties Company
Bartlesville, Oklahoma

PRIOR TO 1952 the need for a special type mud between tubing and casing had not become critical. In years since then, muds for this use have, by necessity, demanded more thought. Workover expenditures in the $50,000 to $100,000 range are not uncommon due to the inadequacy of common drilling muds — and some specially prepared muds — as protective fluid above the packer.

Mud used after drilling operations have been completed may be classified as completion, packer, or workover mud. It would be an ideal situation if all three of these were one and the same, but such is seldom the case.

The mud discussed in this article is one that can be made suitable for many operations. It is a good mud to spot in the bottom of a deep hot well for logging or completing. Due to its low clay concentration, it is not readily damaged by contamination, making it suitable as a workover mud. If contamination does occur, such as when cement is drilled, it can be successfully treated. More important, however, is its primary function as a packer mud.

Field Tests

The particular packer mud which has probably withstood adversity best, and which as a result has been most commonly used, especially on the Gulf Coast, is the so-called gel-CMC mud. This mud consists of bentonite, sodium carboxymethylcellulose (CMC)*, barite, caustic soda and water.[1]

The formula for mixing this mud is shown in Table 1. Various combinations of bentonite, CMC, and barite, along with treating chemicals, oil, and graphite, were experimented with by many operators before McLaurin and Ford published the formula for the most effective and economical mixture in 1955.

More than 100 applications of new gel-CMC muds have been made in wells above the packer, but to date only a portion of these wells has been re-

*Describes copyrighted tradename "Driscose" of Drilling Specialties Company, Bartlesville, Oklahoma.

TABLE 1. Formula for Preparing One Barrel of Weighted Gel-CMC Packer Mud.

Mud Wt Desired lb/gal	Suggested Fun. Visc. Seconds	Water Bbl	Bentonite Lb	CMC* Lb	Caustic Soda Lb	Weight Material Lb	Final Volume Bbl
20	75–100	.57	1.72	1.15	.46	639	1.0
19	75–100	.61	2.44	1.22	.43	584	1.0
18	75–100	.65	3.27	1.31	.33	535	1.0
17	75–90	.68	4.10	1.37	.27	475	1.0
16	65–85	.72	5.03	1.44	.29	421	1.0
15	60–80	.76	6.05	1.51	.30	367	1.0
14	55–75	.79	7.13	1.58	.32	311	1.0
13	55–65	.83	8.29	1.66	.33	257	1.0
12	50–60	.86	9.50	1.73	.35	202	1.0
11	45–55	.91	10.92	1.82	.36	147	1.0

Formula for Preparing Weighted Gel-CMC Packer Mud—Starting with One Bbl Water.

20	75–100	1.0	3.0	2.0	0.8	1114	1.743
19	75–100	1.0	4.0	2.0	0.7	958	1.639
18	75–100	1.0	5.0	2.0	0.5	820	1.547
17	75–90	1.0	6.0	2.0	0.4	696	1.464
16	65–85	1.0	7.0	2.0	0.4	585	1.390
15	60–80	1.0	8.0	2.0	0.4	485	1.323
14	55–75	1.0	9.0	2.0	0.4	393	1.262
13	55–65	1.0	10.0	2.0	0.4	310	1.207
12	50–60	1.0	11.0	2.0	0.4	234	1.157
11	45–55	1.0	12.0	2.0	0.4	162	1.099

The viscosity obtained with the above amounts of materials will depend upon the hardness of the mixing water.

Should the viscosity not be in the suggested range when the desired weight is reached, add bentonite slowly to raise, or water slowly to lower.

Order of addition of materials — Add caustic soda to water first, then bentonite, CMC and weight material.

TABLE 2. Shear Strengths of Bentonite Mud[4] After Aging at 310 F.

Density lb/gal	Shear Strength/No CMC lb/100 ft²	Shear Strength/0.5 lb/bbl CMC Added lb/100 ft²
12	130	45
14	120	100
16	115	100
18	150	90

NOTE: Curbing the yield of bentonite with CMC not only facilitates handling, but also renders mud more insensitive to water and further bentonite additions.

worked. Table 3 consists of two groups of data on reworked wells where packer muds were used; first, wells in which new gel-CMC mud was placed; second, wells in which conditioned drilling mud was placed.

Temperature Gelation

Much has already been written about temperature gelation. It has been found that above certain critical temperatures, muds containing drilled solids or lime are not safe for use. As shown in the second section of Table 3, high temperatures might be withstood by a well-centrifuged, well-dispersed mud in which most of the light solids have been replaced with CMC.

Using a reconditioned mud to save

TABLE 3. Packer Mud Data of Gulf Coast Wells Using New Gel-CMC Muds

Well Location	Comp. Date	W-Over Date	Elapsed Time	BH Temp.	Depth of Top Packer	Mud Characteristics				Remarks
						Weight	Visc.	W.L.	Type	
Acadia Par., La.	1-55	5-58	3 yr. 4 mo.	200	12,400	14.8	55-60	--	New Gel-CMC	No difficulty circ. mud or pulling tubing
Acadia Par., La.	6-55	7-57	2 yr. 2 mo.	220	12,300	15.5	65	7.5	New Gel-CMC	No difficulty circ. mud or pulling tubing.
Acadia Par., La.	—	—	—	—	—	17.0-17.5	48-53	3.2-3.4	New Gel-CMC/ 5% oil & 2-3 lb/ bbl graphite	No difficulty circ. mud or pulling tubing.
Cameron Par., La.	10-56	6-58	1 yr. 8 mo.	340	14,814	11.8	47	7.1	New Gel-CMC	No difficulty pulling tubing. Broke circ. at 13,496 ft.
Cameron Par., La.	3-56	5-58	2 yr. 2 mo.	358	14,112	12.0	48	5.7	New Gel-CMC	No difficulty circ. mud. Tub. sanded up betw. packers. Cut tub. above top packer, installed jars, broke tub. at 14,119 ft/346,000 lb. pull.
Cameron Par., La.	3-56	10-56	7 mo.	212	10,740	17.7	70	—	New Gel-CMC	Found tub. stuck at 1502 ft. Probably had leak in casing. Fished out tub. plug and aban.
Jeff. Davis Par., La.	5-55	9-57	2 yr. 4 mo.	256	12,795	18.0	73	3.6	New Gel-CMC	Worked 5½ hr in pulling tub. loose. Broke circ. after laying down 138 jts.
Terrabonne Par., La.	8-56	6-57	10 mo.	249	14,982	18.0	75	8.6	New Gel-CMC	No difficulty circ. mud. This well was not perf. New gel-CMC mud was left in hole for 10 mo. before a completion was made.
Brazoria Co., Tex.	4-52	10-53	1 yr. 6 mo.	290	12,720	17.0-17.5	48-53	3.2-3.4	New Gel-CMC/ 5% oil & 2-3 lb/bbl graphite	No difficulty circ. mud or pulling tubing.
Brazoria Co., Tex.	1-53	9-54	1 yr. 8 mo.	269	12,014	17.0-17.5	48-53	3.2-3.4	New Gel-CMC/ 5% oil & 2-3 lb/bbl graphite	No difficulty circ. mud or pulling tubing.
Brazoria Co., Tex.	2-54	11-56	2 yr. 9 mo.	268	12,038	17.5	62	2.8	New Gel-CMC/ 5% oil & 2-3 lb/ bbl graphite	No difficulty circ. mud or pulling tubing.
Brazoria Co., Tex.	11-52	11-53	1 yr.	310	13,938	17.0-17.5	48-53	3.2-3.4	New Gel-CMC/ 5% oil & 2-3 lb/bbl graphite.	Couldn't pull tub., which was shown to be free to max. depth indicator could be run (10,700 ft). Fished tub. out. Pulled 40,000 lb on last 39 ft of fish, which broke stinger leaving seal nipples in packer, indicating assembly was stuck below packer.

Centrifuged and/or Treated Drilling Muds

Well Location	Comp. Date	W-Over Date	Elapsed Time	BH Temp.	Depth of Top Packer	Mud Characteristics				Remarks
						Weight	Visc.	W.L.	Type	
Calcasieu Par., La.	7-54	5-58	3 yr. 10 mo.	190	10,435	16.0	—	—	Unknown. Records show caustic, quebracho & small amount of CMC was added.	No trouble circ. mud. or pull tub. First returns were water. 18 lb mud pumped off bottom.
Lafayette Par., La.	4-56	11-57	1 yr. 7 mo.	235	11,946	17.8	58	2.8	Lime mud watered until lime nil. Prop. maintained/barite, gel and CMC.	No difficulty circ. mud or pulling tub. Broke circ./2200 lb. Pulled stinger out/28,000 lb over pipe wt.
Vermilion Par., La.	12-55	11-57	1 yr. 11 mo.	232	12,425	12.4	51	3.0	Centrifuged low-lime drlg. mud/ 6% oil & 2¼ lb /bbl graphite.	Alkalinity 0.2. Tub. stuck. Worked loose after cut. mud wt. back to 10.5.
Brazoria Co., Tex.	11-53	8-54	10 mo.	267	12,118	17.3	60	2.3	Centrifuged, low pH, low solids drlg. mud.	No difficulty circ. mud or pulling tubing.
Galveston Co., Tex.	10-53	2-54	4 mo.	302	14,540	17.1	56	4.2	Centrifuged, low pH, low solids drlg. mud.	No difficulty circ. mud or pulling tubing.
Matagorda Co., Tex	9-52	12-57	5 yr. 3 mo.	249	11,244	16.0	44	1.6	Low solids, low pH drlg. mud.	Well prod. mostly saltwater for 3 yr. Couldn't pull stinger out. Cut tub. at 8500 ft and pulled. Plug. & aband.
Acadia Par., La.	2-55	5-57	2 yr. 3 mo.	187	11,360	17.7	54	4.6	Gel-barite treated with CMC queb., sapp., soda ash.	No difficulty circ. mud or pulling tub. Brk. circ./2000 lb.

the cost of a new packer mud may not be worth the risk. Even a very small amount of lime in the presence of native clay and shale can cause gelation trouble. A reconditioned drilling mud could experience high gelation at temperatures as low as 200 to 225 F.

The packer muds most likely to create a problem are those weighted in the range of 12 to 18 lb per gal. The thixotropy of such muds then becomes very important. If a mud is pseudoplastic in character, for example, it behaves as a viscous fluid, and on standing will not prevent the settling of weight material due to the fluid's lack of proper gel characteristics.[2] A mud having good thixotropic properties, on the other hand, will prevent settling of weight material and still maintain a viscosity and gel strength in a normal range.

Medium and high viscosity grades of CMC are unique in that they impart immediate suspending ability to packer muds, with no adverse effect on viscosity. This suspending effect was clearly demonstrated when a shut-in gas well in St. Martin Parish, Louisiana, blew out. New gel-CMC muds were mixed at various weights in attempting to kill the well without breaking down the formation. One 750-bbl batch weighing 20.0 lb per gal, mixed according to the formula in Table 1, was contained in tanks for 36 hours with little agitation and no evidence of settling.

At offshore Cameron, Louisiana, another 20.0 lb per gal new gel-CMC mud was mixed after a blowout. A sample was idle for six hours in a cement truck measuring tank with no settling.

Shear Strength

CMC suppresses the gelation or shear strength of bentonite in water.[3] Without CMC, a weighted gel mud that is to remain idle indefinitely might, on contact with heat, develop a shear strength too high for ease of pumping. This phenomenon is shown in laboratory data developed by Baroid Division of National Lead Company (Table 2).[4]

The successful and economical application of this comparatively new gel-CMC type of low-solids packer mud has been proved not only in connection with Gulf Coast drilling operations, but in other areas as well. Numerous major companies have contributed helpful information and data used in the preparation of this article.

About the Author

R. S. (Bob) Baker graduated from Southern Methodist University with a BS degree in geology in 1950, after his schooling had been interrupted by the war.

He had varied experience with roustabout and pipeline crews, and worked for Mud Control Laboratories, Inc., at Oklahoma City before finishing college.

In 1950 he joined Phillips Petroleum Company where he worked as a roughneck in the South Texas and South Louisiana areas before going to West Texas in 1951 as a district mud analyst. Early in 1952 he went to southern Oklahoma in the same capacity. Later he was transferred to Corpus Christi as district engineer for Drilling Specialties Company, Bartlesville, Oklahoma. He moved to Lafayette, Louisiana, as assistant division superintendent of the Southern Division, the position he now holds.

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2. McBurney, Dr. Lane F., "The Polyelectrolytic Behavior of Sodium Carboxymethylcellulose in Drilling Fluids," paper delivered at Meeting of API Southern District Study Committee on Drilling Fluids, Houston, Texas, September 20, 1957.
3. Hoch, R. S., "Completion Practices — Gulf Coast Packer Muds," a company memorandum, July 1955.
4. Tables and laboratory data compiled by Baroid Division, National Lead Company.
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API Southwestern District Meets in Midland

THE AMERICAN PETROLEUM INSTITUTE'S SOUTHWESTERN DISTRICT, meeting in Midland, Texas, on March 4-6, elected L. L. McDonald, Pure Oil Company, Fort Worth, as chairman, to serve until the 1960 meeting of the district. Other new officers of the district are Ellsworth Showen, Gulf Oil Corporation, Midland, chairman of the district advisory committee, and Clancy Olson, Dowell, Inc., Dallas, as district secretary-treasurer.

Vice-chairmen heading up the various chapters in the API Southwestern District are: West Texas, Pat Fletcher, Atlantic Refining Company, Midland; Southeast New Mexico, Guy Baber, National Supply Company, Hobbs; North Central Texas, W. C. Werner, Humble Oil and Refining Company, Wichita Falls; Northwest New Mexico, Ewell Walsh, El Paso Natural Gas Products Company, Farmington; South Plains, Luther Reynolds, Pan American Production Corporation, Brownfield; Northeast Texas, John P. Holle, Sinclair Oil & Gas Company, Gainesville.

The first day's schedule for the meeting consisted of 10 committee meetings. Delegates to the convention met in general session on the morning of the second day to hear opening addresses and to applaud presentation of the API's Citation for Service in recognition of outstanding service to the API's Division of Production. Among the recipients of the citation were: M. M. Brantly, Brantly Drilling Company, Inc., Midland; G. T. Pearson,Continental Oil Company, Fort Worth; P. E. Fletcher, Atlantic Refining Company, Midland; and R. P. Moscrip, Shell Oil Company, Midland. Presentation was made by L. E. Fitzjarrald, Phillips Petroleum Company, and API vice president for production, Bartlesville.

New 1959-1960 officers of API Southwestern District include, left to right, Pat Fletcher, vice chairman for West Texas chapter; Ellsworth Showen, chairman of district advisory committee; L. L. McDonald, district chairman; and Clancy Olson, district secretary-treasurer.

Recipients of API Citation for Service include Robert Moscrip (left), G. T. Pearson (second from left), Pat Fletcher (right), and M. M. Brantly (not pictured). Presentation of the awards was made by L. E. Fitzjarrald, API vice president for production (second from right).

Engineered spooling practices can give you . . .

Safety and Savings in Wire Line Spooling

Part 2
(CONCLUSION)

Careful attention to job and equipment will help you determine the correct spooling method which will result in fast, safe, and economical wire line operations

Lonnie Thompson,
Lebus International Engineers, Inc.
Longview, Texas

A very important angle . . . is the fleet angle. This is the angle between the centerline of the crown sheave and the wire line running from the crown (post) sheave to the spooling drum.

The two measurements setting the fleet angle are the height of the mast and the width of the drum. Fleet angle is the most common source of trouble in spooling. Workable fleet angles depend upon the hoisting operation. They fall in four categories, as shown in Table 1: light loads and fast speeds, use a fleet angle of 1¼ deg; light loads and slow speeds, use 1½ deg; heavy loads and fast speeds, use 1½ deg; heavy loads and slow speeds, use 1¾ deg. Fast speeds are defined in this case as being 100 rpm or more. Heavy loads are those at which the safety factor is reduced to a value of 4 or less.

These are the maximum angles that can be expected to work trouble-free. Larger angles will not spool unless aided by some type of fleet-angle correction device. The results of improper fleet angle is improper spooling, time loss and less line service. Breaking away of wire line from flanges causes voids and gaps. Failure to spool against the flanges is a sure sign of a bad fleet angle.

The correct fleet angle for spooling is not an accident — it is planned and engineered in the unit. For the well servicing contractor, the best working fleet angle is 1¼ deg.

Fleet Angle Calculations

The calculation of fleet angles is based upon two measurements (see Fig. 4): the distance from centerline of sheave to flange, A; and, the distance from drum to sheave, B. The following chart shows the relationship of the ratio of these two distances to the fleet angle.

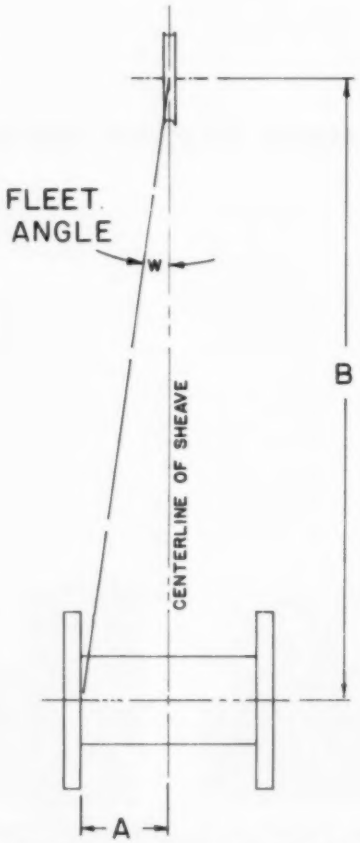


FIG. 4. **Fleet angle** control is one of the most important factors in achieving smooth, even spooling of wire line.

Ratio of A to B (Tangent of W)	Fleet Angle — deg
0.009	½
0.013	¾
0.017	1
0.022	1¼
0.026	1½
0.031	1¾
0.035	2

Example problem. Consider, for example, a hoisting system in which A equals 15 in. for the right-hand flange and B equals 75 ft. The ratio of A to B is:

$$\frac{15 \text{ in.}}{75 \text{ ft}} = \frac{15 \text{ in.}}{900 \text{ in.}} = 0.0167$$

From the chart, it is seen that this ratio is equivalent to a fleet angle of almost 1 deg for the right-hand flange. This falls within the recommended range for proper spooling (from ¾ to 1½ deg).

Then, suppose that A for the left-hand flange is 30 in. The ratio of A to B is:

$$\frac{30 \text{ in.}}{900 \text{ in.}} = 0.033$$

This ratio, from the chart, shows the fleet angle for the left-hand flange to be between 1¾ and 2 deg. Since this angle is greater than the recommended angle, either the sheave should be moved or the left flange should be moved in to correct the fleet angle.

Fleet Angle Correction Devices

Not every hoisting condition will permit a desirable working angle for the job. In such cases, devices are used to correct the angle. The larger the unit and the heavier the load, the more costly the correction device.

One such device that is common to all is the wire line stabilizer used on

most drilling rigs. The stabilizer, properly rigged with weight buckets, serves primarily to hold the line against the flanges when spooling light loads. With improved spooling methods now in use, the stabilizer would be unnecessary with a proper fleet angle. However, due to the location of the fast line sheave, they are usually necessary to obtain good spooling due to excessive fleet angles on one side of the drum or both.

Other devices in use are geared, double threaded leadscrew assemblies which are powered by rotation of the drum. Aside from the cost to build and install such devices, they have often failed to work properly due to the method of spooling previously used. Their failure is due to the fact that helical or parallel (single crossover) spooling does not put the same number of wraps of line on each layer, thus, the device when spooling multilayers gets out of time with the reeling in, or paying out, of the line. However, with the two-crossover system, it can be geared to function properly because each layer has the same number of wraps of line.

In recent years, there have been other types of devices for fleet angle correction which operate by movement of the line. They are limited to definite fixed working angles depending upon the device. Such factors as angle of swing, or movement of the spooler to the amount of angle build-up of the line, limit the use of these devices. They are also limited by the width of the drum and the amount of line build-up permitted.

To get a device that would work properly on a swabbing drum which is both wide and with a large angle build-up of line due to spooling many layers of line, the spooling device, to work by the movement of the line, must then be large and require much working room. Consequently, these devices could not be used on many compact service units unless designed into the unit. There has been a lot of experimental work done lately to find the solution to the problem of excessive fleed angle because of the need for such a device. Not only in the oil industry, but in the marine and industrial hoisting applications as well.

Such fleet-angle correction are not inexpensive. For many applications, they are not too practical, but the time is coming when derrick height will be governed only by the amount of rods or tubing to be pulled. It will have no effect on the spooling due to such improvements.

Minimum Line Tension

No spooling job can be accomplished, regardless of the equipment, unless there exists enough pull on the line to spool it tight on the drum. The tension required depends upon the size of the line, diameter of the drum, and the speed of operation. The smaller the line, the less tension is required. The faster the hoisting speed, and the smaller the drum diameter, the larger must be the tension required to spool.

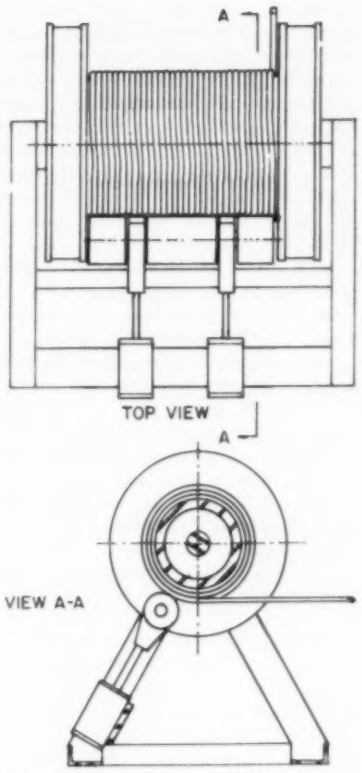


FIG. 5. **Pressure roller**, actuated by springs, air, or hydraulics, assists in correct spooling of slack or loose wire line.

For instance, a 1⅛-in. drilling line can be spooled on a 12¾-in. drum. But to do this, more weight is required in the traveling block equipment to get the proper tension for spooling than would be necessary for a 16 or 18-in. drum. The line would also give less service due to bending stresses. Speed of operation is a big factor especially where the angle of spooling exceeds 1 deg because, if line tension is small, fast speed causes the line to break away from the flanges.

There are many practical devices used to correct for low line tensions, even though they are seldom necessary in oil well drilling and servicing businesses. Some applications use a large rubber roller applied at the drum to keep the line positioned correctly. Such a device is illustrated in Fig. 5. This is successful with grooved drums and is used primarily with parallel-type spooling because it is necessary to hold the line in the groove at all times.

Tensioning sheaves operated manually, by air, or by hydraulics, can be used by locating at the fair lead or fast sheave, depending upon the spooling set-up. Spring-loaded line-tensioning devices are used in the crane hoist field on some lines. It is not inaccurate to say that almost every application has its own type of installation due to positioning, space requirements, etc. It is almost impossible to get too much line tension for most hoisting jobs and like every other phase of spooling, it affects the service life of the line.

An important suggestion for keeping slack line from forming on the drum is for the rig operator to throw out the clutch a moment before taking his foot off the engine throttle. This lets the hoisting drum coast at traveling speed during this speedy operation.

Wire Line Tolerances

The tolerance of a new line is important to the user. For any given size line a maximum and a minimum tolerance has been set up by the API. A line that is undersize is always undersize at any point during the life of the line and will reach throw-away point sooner than those up to standard. An oversize line is subjected to excess scrubbing and wear in sheaves and if a grooved drum is used, it may not spool properly before being damaged at some critical point. The contractor should know and insist on a line of the proper API size.

The nominal diameter of wire line designates the lower tolerance limit. Table 2 shows the permissible oversize of wire line above the nominal diameter. (The diameter of a wire rope is expressed by the diameter of a circle enclosing the line.)

TABLE 2. Diameter Tolerances of Wire Rope.

Nominal Diameter (Lower Limit of Tolerance) — in.	Permissible Oversize — in.
0 to ¾	1/32
13/16 to 1 1/8	3/64
1 3/16 to 1 1/2	1/16
1 9/16 to 2 1/4	3/32
2 5/16 and larger	1/8

Sheave Groove Tolerances

Sheave grooves must be properly matched to the wire line in order to provide proper support for the line as it passes over the sheave. Tight grooves cause excess wear of the line through binding the strands. Large grooves allow the line to flatten as it passes over the sheaves which in turn causes rapid deterioration of the line.

Table 3 shows the sheave groove diameter tolerances allowed for various nominal sizes of wire line. (Sheave grooves should be measured by means

of a groove gage which is usually made to include the standard oversize tolerance.)

TABLE 3. Sheave Groove Diameter Tolerances.

Nominal Diameter — in.	Tolerances of Groove — in.
1/4 — 5/16	+ 1/64 min to 1/32 max
3/8 — 3/4	+ 1/32 min to 1/16 max
13/16 — 1 1/8	+ 3/64 min to 3/32 max
1 3/16 — 1 1/2	+ 1/16 min to 1/8 max
1 9/16 — 2 1/4	+ 3/32 min to 3/16 max
2 5/16 — and larger	+ 1/8 min to 1/4 max

Match Wire Line and Job

The selection of the proper wire line depends upon the job and the hoisting equipment. The type of work is more important than the hoisting drum. For instance, on a drilling rig with a small drum diameter, it is sometimes wiser to use a 6 × 21 wire rather than a 6 × 19 IWRC. The 6 × 21 is a little more flexible. The improved plow steel lines are 15 percent stronger and in many cases very desirable for rugged service — but again one must consider his equipment. While the improved plow steel line is stronger, it is also stiffer and may require a heavier traveling block assembly to spool successfully, particularly if the drum diameter is a minimum for the wire line size to begin with.

For units spooling on a plain drum, rod and tubing drums for instance, a good rule of thumb is to select a right lay line for left hand spooling and a left lay line for right hand spooling.

Swabbing lines have presented some problems of late inasmuch as operating conditions, acid, etc., have made it necessary to improve the core in the wire line to give better service. Plastic cored lines have, in some cases, pulled down too fast; consequently, some difficulty has been encountered in selecting a pitch on the groove that would give the most service. It has been necessary recently to change the pitch of the groove for swabbing lines to obtain better service.

Recommendation for the proper wire rope is a service provided by the wire line service engineer. He will also suggest the proper handling and working procedure. Call him when the task arises as he may help you.

Of all the things that can be said about the use and service of a wire line for any job application, the most important thing is the proper instruction to the crew in its use and the adherence to a good inspection system. So many factors are involved with wire line spooling that no system can replace the necessity for a constant inspection system.

It pays to know the condition of your line at regular intervals. Use gages and micrometer readings to determine the real condition of the line. By doing so, you can often detect sources of trouble in advance, such as a faulty sheave, bad crossover, obstruction in the derrick or at other points which may damage the line. It will also tell you when to cut or change ends of the line, or whatever course is necessary in the handling procedure.

As an example, for a 1⅛-in. drilling line, cutting in will begin when the line wears down 65 to 75 thousandths of an inch below the tolerance of the groove. If the hook load is rather light, this is 85 to 90 thousandths below new size and about 10 thousandths of an inch before broken strands should appear. For rigs with heavy hook loads and traveling block assemblies, the line will begin to break up before cutting in occurs and it will often be necessary to make a long cut to remove the unsafe line. This can be avoided by the suggested proper inspection system.

Cut-Off Program

A proper cut-off program is designed to remove worn wire line from the system before the line fails or causes damage to related hoisting equipment. It is necessary, of course, to keep accurate records of ton-mile service done by a line to be used as a basis for the cut-off program. Recommended cut-off procedures for various combinations of wire line, drill pipe, and hole depth are shown in Table 4. This table is, of course, general and based upon idealized conditions and rather broad estimates of ton-mile service.

Ton-Mile Service and Length of Line

Many cut-off systems have been devised by operators in an attempt to improve the ton-mile service per length of line. Surprisingly enough, the length of new line purchased can be an important factor in getting the most service per foot of line. As an illustration, consider the examples which follow. The three examples are calculations of service rendered by three different lengths of 1¼-in. wire line in a 136-ft

TABLE 4. Wire Line Cut-Off Schedule.

Wire Line Size —in.	Drill Pipe Size —in.	Excess Weight[1] —lb	Ton-mile Service Limit —ton-miles	Cut-off Length[2] —ft	Round Trips Equivalent to Ton-Mile Service Unit at Various Well Depths: 0 to 4000	4000 to 5000	5000 to 6000	6000 to 7000	7000 to 8000	8000 to 9000	9000 to 10,000	10,000 to 11,000	11,000 to 12,000	12,000 to 13,000[3]
1	3½	15,000	500	25 to 35	18	10	8	6	4	3	—	—	—	—
1	3½	20,000 to 25,000	600	25 to 35	16	9	7	5	4	3	—	—	—	—
1⅛	3½	20,000 to 25,000	650	25 to 35	20	10	8	6	5	4	3	2	1	—
1⅛	3½	30,000 to 35,000	900 to 1000	45 to 55	15	10	8	6	5	4	3	2	—	—
1¼	3½	25,000 to 30,000	1000	55	18	13	10	8	6	5	4	4	3	2
1¼	3½	35,000 to 40,000	1200	65 to 70	22	12	9	7	6	5	4	3	3	2
1⅜	4½	40,000 to 45,000	1800	68 to 85	21	14	13	10	8	7	6	5	4	3

1. Excess weight refers to the total weight of traveling block, hooks, and elevators and 1 to 20 drill collars. This chart is based on the assumption that the block, hooks, and elevators weigh approximately the same as the drill collars. If actual conditions vary appreciably from this assumption, ton-mileage should be calculated.
2. Cut-off length should be equal to a whole number of drum-wraps plus ½ or ⅓ of a wrap.
3. When using 1¼-in. line below 13,000 ft, add one coil from reserve every round trip and cut off approximately 60 ft after 1200 ton-miles use.

derrick with a 24 to 36-in. diameter drum core.

Example 1

New spool of line . . . 5000 ft
Less: Amount to string blocks and drum . . . 1400 ft
Leaves: Reserve on spool . 3600 ft
Less: Emergency factor for one or two long cuts . 600 ft.
Leaves: Amount left for drum end cuts . . . 3000 ft
Average drum end cut to be approximately 60 ft every 1200 ton-miles. (See Table 4.) Amount left for drum end cuts (3000 ft) will allow 50 cuts, or a total of 60,000 ton-miles of service.
Ton-mile service per foot of line = 60,000 ton-miles ÷ 5000 ft = 12 ton-miles per ft of line

Example 2

New spool of line . . . . 3500 ft
Less: Amount to string blocks and drum . . . 1400 ft
Leaves: Reserve on spool . 2100 ft
Less: Emergency factor for one or two long cuts . 300 ft
Leaves: Amount left for drum end cuts . . . . 1800 ft
Average drum end cut to be approximately 60 ft every 1200 ton-miles. (See Table 4.) Amount left for drum end cuts (1800 ft) will allow 30 cuts, or a total of 36,000 ton-miles of service.
Ton-mile service per foot of line = 36,000 ton-miles ÷ 3500 ft = 10+ ton miles per ft of line

Example 3

New spool of line . . . . 2500 ft
Less: Amount to string blocks and drum . . . 1400 ft
Leaves: Reserve on spool . 1100 ft
Less: Emergency factor for one or two long cuts . 200 ft
Leaves: Amount left for drum end cuts . . . . 900 ft
Average drum end cut to be approximately 60 ft every 1200 ton-miles. (See Table 4.) Amount left for drum end cuts (900 ft) will allow 15 cuts, or a total of 18,000 ton-miles of service.
Ton-mile service per foot of line = 18,000 ton-miles ÷ 2500 ft = 7+ ton-miles per ft of line

These examples illustrate that, generally, better ton-mile service per foot of line will be given by longer lines. The examples are not meant to show maximum or minimum service available from a 1¼-in. line, but rather simply show the general effect of line length on total service. Different types of equipment and individual operations may increase or decrease the ton-mile service possible per foot of line.

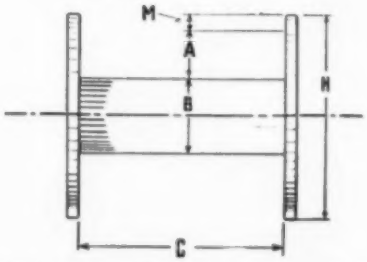
Capacity of Drum

A formula has been devised for calculating the capacity of a drum or the amount of wire line on a drum. The formula is based on uniform spooling and will not give correct results if the line is wound non-uniformly on the drum.

$$L = (A + B) \times A \times C \times K$$

where

L = Length of wire line, ft
A = Depth of line layer, in. = $\frac{H - B}{2} - M$
B = Diameter of drum, in.
C = Width of reel between flanges, in.
M = Desired clearance, in.
K = Constant as shown in table below



The value of "K" can be computed from the formula

$$K = \frac{.262}{d^2}$$

where d is the nominal diameter of the wire line. The values corresponding to several sizes of line are listed in the following table.

Nominal Diameter — in.	K
¼	4.19
5/16	3.31
3/8	2.68
7/16	1.86
½	1.37
9/16	1.05
5/8	.828
11/16	.671
¾	.554
13/16	.466
7/8	.397
1	.342
1⅛	.262
1¼	.207
1⅜	.168
1½	.139
1⅝	.116
1¾	.099
1⅞	.086
2	.075
	.066

TABLE 1. Maximum Fleet Angles Recommended.

	Fast Running	Slow Running
Light Loads	1¼ deg	1½ deg
Heavy Loads	1½ deg	1¾ deg*

Fast running: 100 rpm or more
Heavy Loads: Safety factor of 4 or less
*Under constant tension

Weight and Circumference of Wire Line.

Nominal Diameter —in.	Approximate Weight per ft —lb	Approximate Circumference —in.
¼	0.10	¾
5/16	0.16	1
3/8	0.23	1⅛
7/16	0.31	1⅜
½	0.40	1⅝
9/16	0.51	1¾
5/8	0.63	2
¾	0.90	2⅜
7/8	1.23	2¾
1	1.60	3⅛
1⅛	2.03	3½
1¼	2.50	3⅞
1⅜	3.03	4⅜
1½	3.60	4¾
1⅝	4.23	5⅛
1¾	4.90	5½
1⅞	5.63	5⅞
2	6.40	6¼

This table aplies to all types of 6x19, 6x17, and 6x21 hard fiber core wire lines.

Conclusion

As wells are drilled deeper and deeper every day, the role of wire line in drilling and servicing operations becomes more important. The investment of a contractor or operator in wire line must be protected by properly engineered installation and operation of the entire hoisting system. Good spooling practices, based on the nature of the job and the equipment involved, are the first step in any program designed to achieve maximum safety and service from wire line.

Maintenance and Care of Wire Line.

A wire rope has often been called a machine. Certainly, an operator should be as careful with the maintenance and care of a wire rope as he is with his other "machinery." Here are a few basic rules which will help you get the longest life and best performance from your wire line.

- **Select the proper line** for the work it will be expected to do. Proper length, diameter, construction, and grade will also be determined by the type of equipment with which the line will be used.
- **Employ the proper spooling method** for controlling and safeguarding wire line.
- **Observe the initial break-in period carefully.** Like an engine, wire line can be severely damaged through misuse during its first few hours of service.
- **Inspect sheaves regularly** for wear and misalignment.
- **Lubricate the wire line periodically** and especially before storage.

★ ★ ★

Long Run Gas Engines Spark Production Economy Drive

Arthur Langton,
Consultant
Los Angeles 17, California

BY MEANS of important engine modifications, remarkable progress has been made in extending the service life of gas engines operating in isolated locations.

The modifications have been successfully used on the lower horsepower range of engines which are commonly used in oil production lease operations. None of the modifications used comprises anything new except for their proper combination and use.

Almost as important as extending engine life, the lengthening of servicing periods offers significant savings. In fact, these two benefits have given rise to a new service being offered by several independent companies on the West Coast. These companies provide power for lease operations on a contract basis.

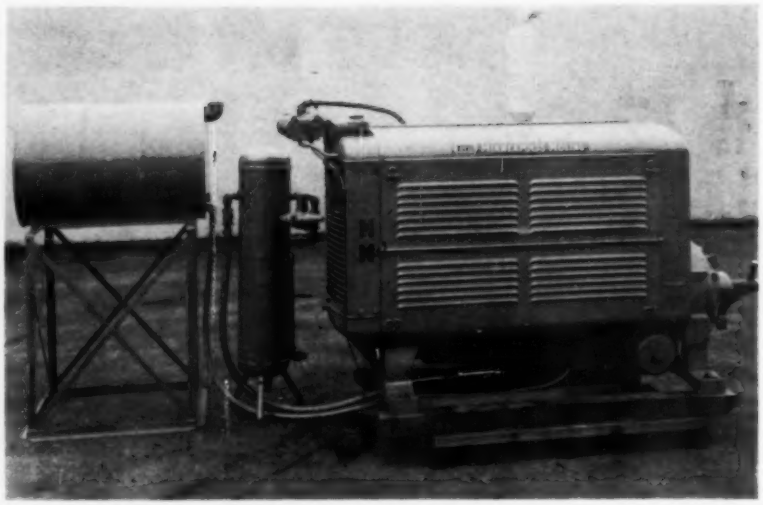


FIG. 1. **This engine has been rebuilt and equipped with many long-run features** and is available on a lease basis. Shown are the lubricating oil drum, the separator for cleaning the fuel gas, and the exhaust water condenser mounted on the radiator.

A Look Back

It seems a far cry from Longfellow's one-hoss shay and the Zeppelin made famous, or infamous, during World War I, to certain cost-cutting modifications of today's gas engines. But the connecting thread makes an interesting story filled with important implications in oilfield production economy.

Zeppelin designers had a tough problem in compensating for loss of weight and balance through fuel consumption in their dirigibles. They obtained an ingenious solution by condensing the exhaust gases of their Maybach engines to create a counter-balancing water supply. However, with the obsolescence of the "big bags," this utilization of the internal combustion exhaust gases fell by the wayside until comparatively recently.

The basic idea was revived to reduce the need for expensive daily checking of radiator water level of gas engines in lease operations. Today's application consists of a small condenser mounted on the radiator to utilize a portion of the exhaust gases to produce pure, mineral-free water which automatically feeds into the radiator as needed.

But what about the one-hoss shay? The basic construction principle of that celebrated vehicle, wherein each component equaled every other component in strength and durability, closely resembles the goal toward which designers and operators of today's extended-life engines are striving, and the progress already made, marks an epoch in oilfield gas engine operation.

What Is a Long-Run Gas Engine?

Various terms have been applied to gas engines which have been modified to prolong the interval between service checks. Long-life, extended-service, and long-run are in common use, and all mean the same thing. They refer to gas engines which have been designed or equipped to operate continuously for amazingly long periods (by old standards) without requiring maintenance of any kind. Check-free runs of 30 days, three months, and six months are being achieved with increasing frequency, particularly in California, where the long-run concept has received its greatest impetus. In specific field tests engines have been allowed to operate for over 12 months without being touched and have proved equal to the task. One of these engines, on being taken down after its marathon run, showed only insignificant wear, and apparently could have operated another year or so without service.

These year-long runs, of course, were extremes, but they indicate the possibilities. As far as the basic gas engine is concerned, its possibilities of uninterrupted service life are indefinite. Breakdown occurs most frequently in the secondary equipment: Cooling, lubrication, and ignition. Consequently, long-life modifications have been focused in these areas.

Radiator Water Supply

As indicated, the radiator water supply received early attention, since this demanded the most frequent field attention. Over 10 years ago, L. A. Billington, now automotive superintendent for the southern division of Union Oil Company of California, attacked this problem. He suspected that many of the ills which beset the internal combustion engine stemmed from the frequently-overlooked water supply, and later developments proved him correct. The lime deposits in engine blocks and radiators, which resulted from the large volumes of water being added to the engines, set off a chain reaction of difficulties which materially increased engine wear. Billington reasoned that if water addition were reduced, liming would be reduced with it. Consequently, he set about replacing the old open water-cooling tanks on some single-cylinder engines with small radiators incorporated in a closed pressure-cooling system.

The results justified the action. Liming was reduced. Cooling efficiency increased. Upper cylinder wear was reduced. Lubricating oil gave longer life. According to Billington, the immoderate addition of water to the radiator causes almost as much trouble to internal combustion engines as too little water. The human tendency of maintenance men to pour water into the radiator until it overflows proves a very expensive form of generosity. Today's exhaust condenser has provided a fine field solution to this problem. But even on this device a by-pass had to be provided to discharge water in excess of that actually required by the radiator.

Other parts of the condenser include a primary purifying stage, in which undesirable combustion products are discarded, and a final condensing stage which supplies mineral-free make-up water to the cooling system through a float check valve.

The exhaust condenser and the oil level regulator have proved so successful that approximately 80 percent of all gas engines presently purchased for use in California oil fields are equipped with them. However, the exhaust condenser system has not proved effective where sour fuel gas is employed.

Crankcase Oil Supplied Automatically

The second area of expensive frequent maintenance, that of keeping a constant oil level in the crankcase, succumbed to a less spectacular but equally effective device. This consisted of a specially designed float valve for external attachment to the engine crankcase. Insensitive to vibration, it delivers just the right amount of oil from an external reservoir which may carry enough to last for six months.

FIG. 2. This pumper is operated by a typical long-run unit. Shown is the oil drum leading to the oil level regulator on the crankcase, and the make-up water condenser with the hose leading from the exhaust stack.

Again, other important savings developed from this application of automation. Billington and others discovered there was an important difference between the amount of oil an engine really needs and the amount consumed by periodic hand filling. Typical, was a series of pumpers on one lease where the maintenance personnel had established for themselves a somewhat arbitrary schedule of checking the crankcase. Thus, a quart of oil a day was added to one engine, a pint to another, and so on throughout the whole lease. But, by using oil level controllers, which rigidly fixed the oil level at a pre-determined point, a substantial reduction was made in the amount of oil consumed. Once more, the human tendency to "fill 'er up to the top" caused a higher consumption than was necessary. And to this total must be added the amount lost in spillage.

Trouble from oil picking up dirt from unclean transfer cans was also eliminated. One lease operator in the Bakersfield area experienced a considerable amount of difficulty from grasshoppers plugging his oil screens. Investigation showed that a maintenance man employed transfer cans left at the well site to supply make-up oil. These cans made fine homes for San Joaquin Valley grasshoppers, but it was a bad break for engines and 'hoppers alike when the lease hand neglected to foreclose on the occupants. Installation of a long-term oil supply with an oil level regulator eliminated this trouble source.

Ignition Modification

The ignition received severe modification. One school of thought advocates the use of aircraft-type high tension magnetos with platinum point spark plugs. The use of this type of plug reduced the need for frequent gap adjustment and reduced the magneto load, thus lengthening the life of the magneto (magneto load is increased with wider spark gap).

Another school of thought supports the use of a low-tension ignition system, claiming that the possibility of better shielding, reduced fire hazard, and lessened plug and magneto wear justify the higher cost of the power source. Both schools can point with pride to the fact that their systems have enabled gas engines to take another long step toward the one-hoss-shay ideal.

Other Modifications

Solids entrained in the fuel gas were

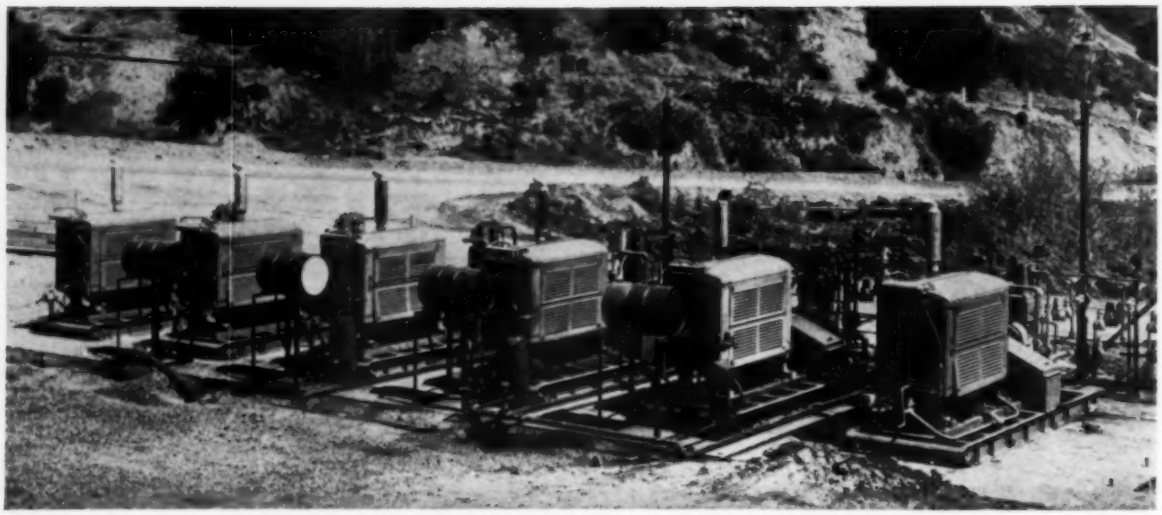


FIG. 3. **A battery of long-run pumpers in a California oil field.**
Note the oil drums and the make-up water condensers on the radiators.

examined and found to be a trouble source. In one West Texas field, pumper engine valves had to be ground at six-month intervals because of pitting resulting from solids picked up in a dirty gas line. The installation of cleansers or separators permitted the engines to operate for two years without a valve job. Practically all extended-life gas engines now are equipped with separators or filters for protection.

In a sense, modifying a gas engine to extend the interval between services has been a self-regulating proposition. Elimination of the need for frequent checks of oil and water level unmasked other points of too-frequent maintenance requirements. Radiator hose, hose connections, and fan belts which once were tightened or replaced as a matter of routine at regular intervals became the culprits requiring the most frequent servicing. Servicing intervals for these items have been lengthened by using premium materials.

Successful Tests Have Generated Much Interest

Engine manufacturers have been quick to respond to the interest in motive power that requires a minimum of attention. Several companies now include certain long-life components, such as water condensers and oil regulators, at the factory. Some are reexamining the whole engine make-up to determine what else can be modified to reduce the need for "dat ole debil" frequent maintenance.

The selection of engine type to meet a particular job now receives much closer scrutiny than ever before. Both multi-cylinder and single or dual-cylinder engines are suitable for long-life adaptation. In California the tendency in the past has been to invest in multi-cylinder engines for oilfield operations. Today interest in the simpler engines has been revived, particularly in the lower horsepower brackets. One oil company recently purchased 12 single-cylinder engines to replace worn out multi-cylinder engines in pumping operations. This company plans to continue with similar replacements throughout the area. The ease of making repairs in the field to single-cylinder engines counts as a big factor here. However, the current high cost of these engines in the greater horsepower ratings legislates against their widespread use for heavy loads.

Selection of the right horsepower for a particular job also receives more attention than it once did. There was a tendency on the part of some operators to over-power their jobs, their arguments following the lines of "If 20 hp is good, 40 hp is better." Broken down costwise, it just did not work out that way. In a typical case the fuel used per brake-horsepower hour on an oversized engine was 14 cu ft compared with 9.5 cu ft for an engine adequate for the job.

While engine type and proper horsepower do not, necessarily, have anything to do with the long-life concept, all of these factors enter into the overall picture of production economy.

A Complete New Service Develops

One of the most significant developments to arise out of the movement toward long-run gas engines has been the concept of leased power. One California company is offering engines on a lease basis. These engines have been modified to permit long runs without servicing. Important modifications are the additional special alloy bearings, aircraft-type high tension ignition and platinum plugs, a make-up water condenser; automatic oil level control; and a separator to remove solids from the fuel. In addition, the oil pan is fully jacketed to permit the oil to be heated by hot water from the radiator. This feature proved particularly effective during wintertime operations in the Williston Basin and other cold spots.

For a fixed sum, depending upon horsepower requirements, this company offers, not an engine, but the requisite power. The application claims many advantages. No capital investment is required for power. The operator is relieved of all engine maintenance requirements. Costs are fixed and predictable. Bookkeeping is simplified. Power changeover to meet altered requirements is simple and quick. Several operating companies have adopted eased power for its pumping units and compressors. Others are doing a lot of pencil work and are casting an interested eye at the leased power concept.

It's an interesting development, and one with many ramifications. The very idea of leased power would have been inconceivable without the extended-service engine. The need for daily service would have made leasing costs prohibitive.

Conclusion

One of the best things to arise out of the long-life development is the conviction, held by many operators and manufacturers, that the end of these improvements is not yet in sight. Again to quote Billington of Union, "We are moving toward a hypothetical goal in which all parts of the gas engine will last and last, year after year, until they all have to be replaced at the same time." And this, of course, was the goal achieved by Longfellow's wonderful one-hoss shay. ★ ★ ★

Integrated oil field manufacturing facilities of Continental-Emsco's Houston plant with almost 8 acres under roof on a 77-Acre site.

Oil Equipment Firm Integrates and Expands Manufacturing Facilities

F. M. Mayer, president, Continental-Emsco Company, and vice president of The Youngstown Sheet and Tube Company.

CEREMONIES early in March 1959 culminated a $3 million expansion program at its Houston, Texas, Garden Villas plant of Continental-Emsco Company, prominent oil field equipment manufacturer with headquarters at Dallas. The original Houston plant, established in 1926, was expanded when over a year ago the company's Los Angeles facilities were closed and machinery and tools were shipped to the Houston location. The new expansion was to integrate the company's facilities to meet the growing equipment needs of an expanding world-wide oil industry.

Also expanded was Continental-Emsco's Garland, Texas, plant in anticipation of the increased need for oil and gas production equipment. New laboratories and engineering departments were added as well as extensions to shipping and manufacturing bays. New facilities for making swivel joints were added. Complete metal processing equipment is available to upset, thread, normalize, draw and paint sucker rods, made in four grades. Subsurface pumps are another product of the Garland plant.

Coincident with the plant expansions was the announced opening of larger Dallas headquarter offices in the enlarged and renamed Mercantile-Continental Building at 1810 Commerce.

Houston plant modernized, doubled in size. The Garden Villas plant in Houston was doubled in size . . . from its under-roof area of 4½ to almost 8 acres. The plant site was increased from 66 to 77 acres. New facilities include a new engineering building, a new laboratory building, a new pattern storage building. About 100,000 sq ft were added in the construction of a structural steel shop, 3900 sq ft to the personnel building, and 29,000 sq ft to the main shop building.

S. A. Martin, plant manager, Continental-Emsco Company's newly-expanded Houston plant.

Many of the tools at the plant have been custom designed and built. Huge slab mills permit accurate milling of surfaces on large forgings and assemblies, and a 600-ton capacity press brake permits forming of heavy structural shapes. The plant is equipped with a large number of precision machine tools, which include turret lathes, engine lathes, vertical and horizontal boring machines, milling, broaching and grinding equipment and gear generating machines for cutting herringbone, helical and spur gears and roller chain sprockets.

Company officials participating in the plant opening at Houston included: J. L. Mauthe, chairman, and A. S. Glossbrenner, president, The Youngstown Sheet and Tube Company; Frederick M. Mayer, vice president, The Youngstown Sheet and Tube Company and president, Continental-Emsco Company; and the following Continental-Emsco executives: F. I. Brinegar, executive vice president; and W. T. Powell, executive vice president in charge of manufacturing.

Over 1000 oil industry and defense officials viewed the new Houston facilities, while earlier, 2900 plant employees and their families were feted at an open house. ★ ★ ★

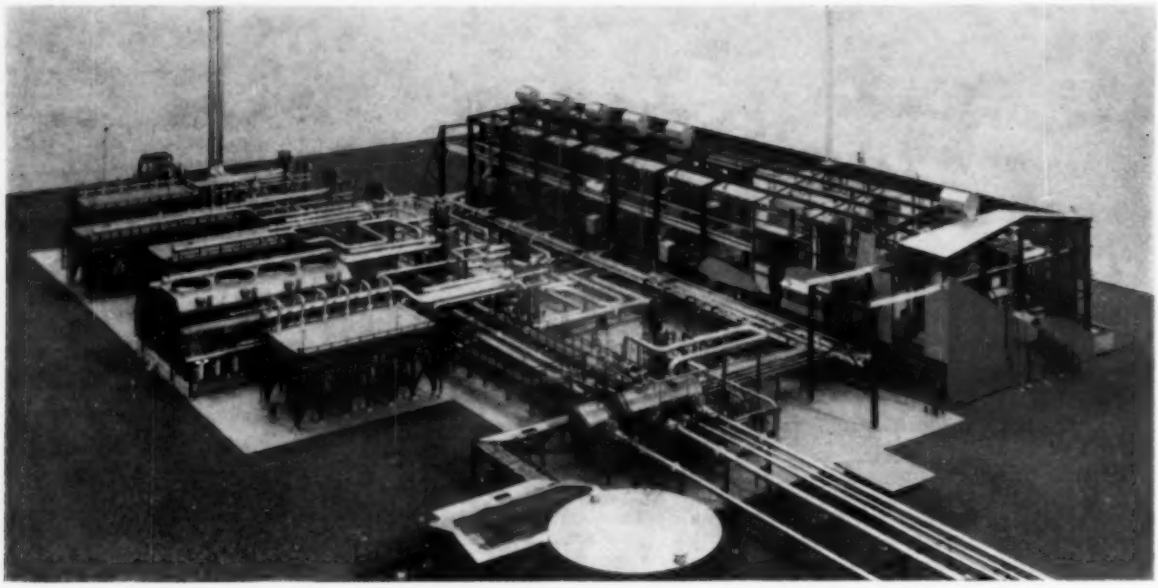


FIG. 1. Scale model of Aramco's new gas-injection plant in the 'Ain Dar area of the Ghawar field, Saudi Arabia.

Saudi Arabia is site of Aramco's new . . .

'Ain Dar Gas-Injection Project

Arabian American Oil Company is investing $30,000,000 in a project which will gather and inject 200,000,000 cu ft of gas per day in the Ghawar field of Saudi Arabia

John W. Barker
Arabian American Oil Company, Saudi Arabia

TO CONSERVE NATURAL RESOURCES and to maintain reservoir pressures the Arabian American Oil Company is installing a 200,000,000 cu ft per day gas-injection plant in the 'Ain Dar area of the Ghawar field in Saudi Arabia. Ground was broken in November 1957. Completion was scheduled for the end of 1958. The overall project, including pipelines, power lines, conversion of the gas-oil separator plants feeding the injection plant and miscellaneous work will cost approximately $30,000,000.

Gas comes to the injection plant from the high-pressure separators of five separator plants. These traps operate at a nominal pressure of 175 psig. By above-ground, restrained pipelines the gas will reach the centrally located injection plant at 150 psig where it will be compressed to approximately 2100 psig. A picture of 3/16-in. scale model of the injection plant is shown in Fig. 1.

Fig. 2 shows the location of the separator plants supplying gas to the injection plant plus the overall gathering and injection line system.

Piping System

There is a total of 34.0 miles of 22, 24, 26 and 30-in. gathering lines. The lengths of each size were specifically selected to permit triple nesting of 22, 24, 30-in. and 24, 26, 30-in. pipe to reduce ocean freight costs. At a central yard the gathering line pipe is separated and double-ended before stringing along the rights of way. There are 19.6 miles of 10, 12, and 14-in. injection lines carrying the compressed gas from the plant to the three wells in the north 'Ain Dar area and four wells in the south 'Ain Dar area. These latter lines are of conventional design on sleepers. The weight of the heavy wall injection pipe does not make nesting economically advantageous.

At the gas-oil separator plants, the gas which is to be injected formerly passed from the high-pressure separators through expansion gas turbines driving the pipeline pumps, and then to flares. These turbines are being replaced by electric motors. To provide power for these, a 5600-kw generator is being installed at the gas-injection plant. Power is transmitted to the separator plants over 66 and 13.8-kv lines. The power lines also were extended to Abqaiq to tie into the existing Aramco power distribution system, thus providing an alternate source of power as well as means for making up any deficiencies.

Compressor Plant

All gas compressors in the injection plant are centrifugal. There are five stages of compression. Each compressor and the 5600-kw generator are driven by a separate two-shaft gas combustion turbine. The compressor-driven turbines are rated at 8000 hp each at 100 F ambient temperature and 1000 ft above sea level.

The maximum compression pressure in the plant was set at 2100 psig, the allowable limit of 900-lb ring joint flanges under the ASA Class "A" code rating. Allowing for in-plant pressure drop through the last stage cooler and

scrubber, the maximum plant discharge pressure will be approximately 2075 psig.

It has been necessary to design considerable flexibility into the plant to satisfy a multitude of varying conditions. Some of this flexibility is afforded by provision for shutting down and bypassing any stage of compression without shutting down the entire plant. By this method much of the routine, scheduled inspection and maintenance work can be done stage-wise, thus reducing the time when the entire plant must be down.

Provision has been made for installing a sixth stage of compression should it be desired to increase the plant capacity in the future. The sixth stage would serve as a booster for the five stages already being installed. It would be driven by another gas combustion turbine.

One of the novel features of the plant is the stage bypass piping arrangement. This is shown schematically in Fig. 3. This so-called leapfrog scheme together with a system of double blocks and bleeders permits working on any stage with safety without the necessity of blinding off. This also reduces the number of valves that would be required if more conventional bypassing were used. Main valves range in size and rating from 30-in. 150-lb ASA to 12-in. 900-lb ASA. Each is fitted with a hydraulic operator.

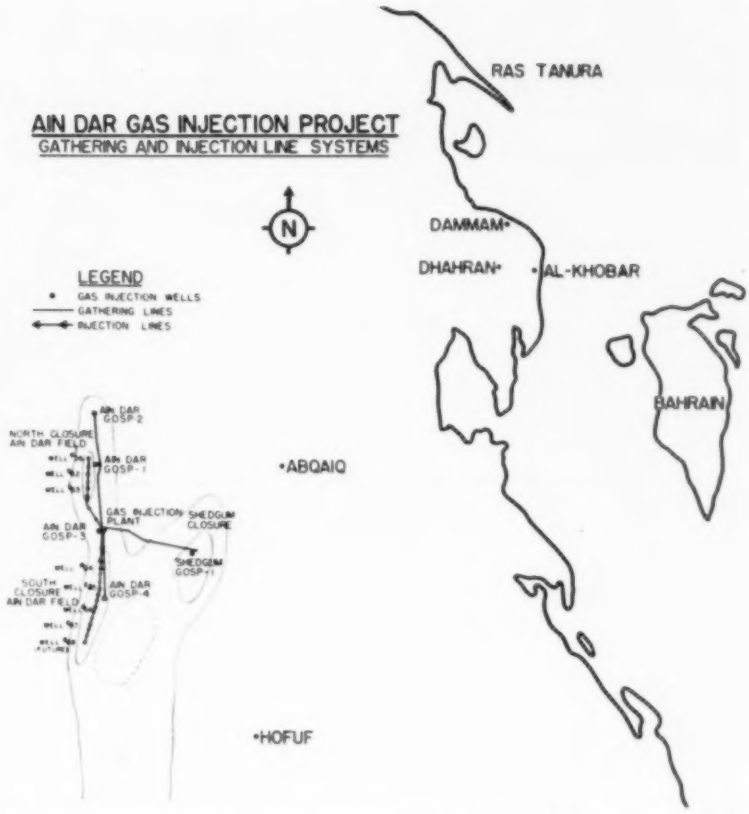


FIG. 2. Map of the gas-injection project shows the layout of gas-oil separator plants, gathering units, gas-injection plant, injection lines, and injection wells.

Gas Cooling System

Cooling the gas after it has been compressed in each stage is accomplished by "fin-fan" units except in the second stage where a combination unit is employed. The latter is a combined cooling tower and "fin-fan" unit which precools the ambient air before entering the finned gas cooling sections. The equipment not only affords cooling of gas to lower temperatures than the straight "fin-fan" units but also provides a source of cooling water for the shell and tube seal oil coolers, plant air coolers, and the air conditioning unit condensers. Process calculations demonstrated the second stage of compression was the optimum location for taking maximum advantage of the unit's lower cooling level to drop out more water from the saturated gas, thus conserving horsepower in later stages for compressing hydrocarbon gas.

Injection gas in each stage passes from the stage coolers to a knockout scrubber drum fitted with a demisting element. This assures a dry gas to the suction of the compressor in the next stage. A cooler and scrubber is provided in the last stage to minimize injection line pressure drop and the quantity of water and hydrocarbon condensate which otherwise would drop out in the injection lines and possibly cause hydrate difficulties.

Scrubbers in the last three stages are multilayer vessels. The fourth stage scrubber, whose 7-ft inside diameter is dictated by normal operation but whose design pressure is based on the plant discharge pressure, in the event the last stage is down and bypassed, has a thickness of 6¾ in. and weighs 78 tons.

Condensate from the individual scrubbers flows through snap-acting level control valves back to the main inlet drum which serves to segregate water and hydrocarbon liquids and at the same time disengage any condensate or entrained crude oil that might enter the plant with the gas to be compressed. Water from the bottom draw-off pot of the inlet drum flows to the sewer. Hydrocarbon liquid flows under inlet drum pressure to the low-pressure trap of nearby 'Ain Dar gas oil separator plant No. 3.

The Author

John W. Barker, *project engineer with the Arabian American Oil Company, graduated from the Massachusetts Institute of Technology in 1941 with a bachelor of science degree in chemical engineering.*

Between 1941 and 1950 he worked for the Pure Oil Company as refinery engineer, Foster Wheeler Corporation as process engineer, Houdry Process Company as process and development engineer and George Armistead Company as consulting engineer.

He joined Aramco in 1950 as a process engineer in the New York engineering department and later became assistant to the chief engineer, New York. In 1954 he transferred to Saudi Arabia as acting engineering coordinator for the engineering and construction system. During 1955 and 1956 he served as coordinator, liaison engineering. Since 1956 he has been working in Rome and in Saudi Arabia as project engineer for the 'Ain Dar gas-injection plant.

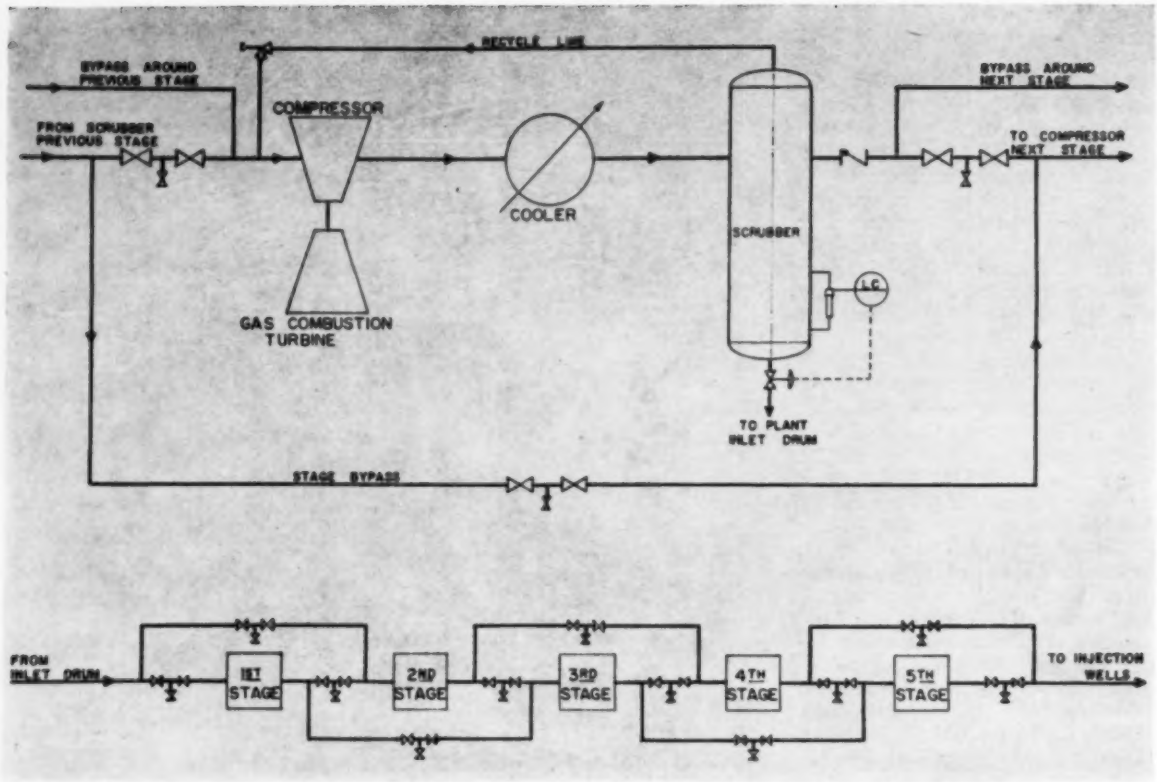


FIG. 3. Schematic diagram of the stage bypass piping arrangement in Aramco's new gas-injection project.

'Ain Dar separator plant No. 3, because of its proximity, plays another unique function in that gas from its low-pressure trap, operating at approximately 50 psig, is conveyed by pipeline to the injection plant to serve as fuel for the gas combustion turbines. In this manner higher pressure gas entering the injection plant is conserved for injection. However, provision has been made for gas from the inlet drum to make up any deficiency in fuel gas should 'Ain Dar separator No. 3 be operating at reduced capacity or be down. A motor driven compressor is provided to boost the pressure of the incoming fuel gas to the 150 psig required for the turbines.

All major machinery and auxiliaries in the plant are located in the 80 by 300-ft building. Principal sections of the building and the equipment in them are:

Main compressor room. Houses the injection gas compressors, their turbine drivers, local turbine control panels, seal oil panels, lube oil coolers, lube oil filters, fuel gas compressor, air compressor and air dryers.

Generator room. Houses the 5600-kw generator, its gas combustion turbine driver, local turbine control panel, lube oil coolers, and lube oil filters.

Control room. Located between the main compressor and generator rooms, it contains the graphic central control panel, generator control panel, power control panel and motor control centers.

Oil room. Houses the hydraulic oil pumps for the turbines' hydraulic starting motors, valve operator hydraulic oil pumps, seal oil tank, seal oil pumps, and a centrifuge for cleaning hydraulic, lube and seal oils.

Battery room. Contains batteries for emergency power required particularly for turning over the turbines in the event the generator and power lines are out of service.

Switchgear room. Contains switchgear, battery chargers, inverter sets, air conditioning compressors and coolers, small transformers, and radio equipment for communications.

Emergency generator room. Houses the 150-kw diesel-driven emergency generator.

Viscosine room. Contains tanks and a centrifuge for cleaning the viscosine used in the air filters.

Fan room. Houses the filters and fans for circulating ventilating air for the building and cooling air for the turbines.

Shop. Contains benches and equipment for routine maintenance of instruments and plant equipment.

All turbine combustion and cooling air and the building cooling air is filtered. The entire building is pressurized slightly to prevent inward seepage of sand almost always present in the outside air. The control room, switchgear room, battery room, shop, and the foreman's office are air conditioned.

Another considerably smaller building houses the fire water pump, utility water pumps, water treating facilities, and pumps for injecting corrosion inhibitor at various points throughout the plant.

The injection plant proper including power generating facilities will cost approximately $17,000,000. The gas gathering lines, injection lines, gas-oil separator plant conversions, power transmission lines and other miscellaneous off-plot work will cost $13,000,000.

Design of the injection plant was by a team of Brown and Root, Inc., engineers in collaboration with Compania Techniche Industrie Petroli, an engineering contractor in Rome, Italy. Off-plot facilities were designed by Aramco Overseas Company engineers in their office at The Hague, Netherlands. All procurement was by Aramco and the Aramco Overseas Company. Construction is by Aramco, International Bechtel, and Arab contractors. ★ ★ ★

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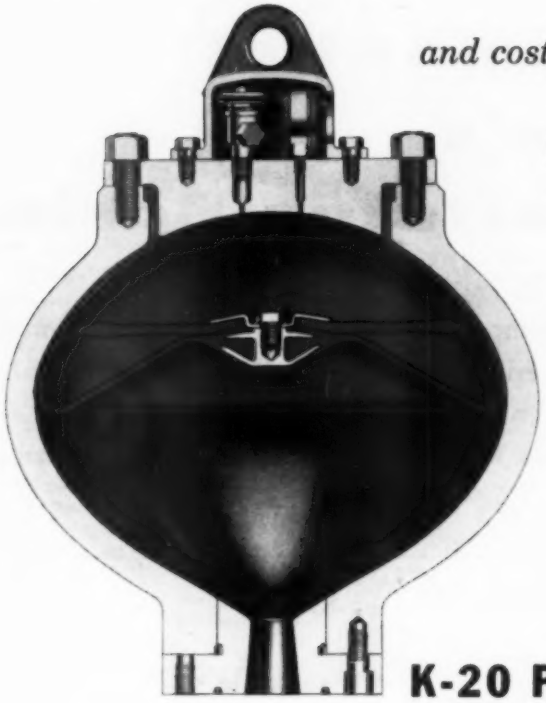

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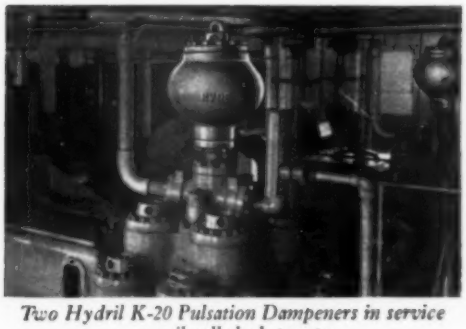

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Lugos Oil Field Accelerates . . .

Development of France's Aquitaine Basin

Joseph A. Kornfeld
Consulting Geologist-Engineer
Tulsa, Oklahoma

The Aquitaine Basin, in southern France, accounted for 96 percent of the country's oil production in 1957. Development of the Lugos field, discovered late in 1956, adds to the importance of this rich basin

THE GROWING POTENTIAL of the Aquitaine Basin of southern France is being emphasized by current development of the new Lugos oil field, situated 16 miles northeast of Parentis. (See Fig. 1.)

Now the fourth largest oil field in the Aquitaine Basin, the Lugos oil field is currently producing in excess of 750 bbl of 20.6 deg API crude oil per day from six wells from depths ranging from 4900 to 5500 ft. Since completion of the discovery well on September 3, 1956, the field has produced 157,342 bbl of oil, of which 120,130 bbl were produced during 1957.

Sole operator of the Lugos field is Esso REP, Societe Esso de Recherches et D'Exploitation Petrolieres, which owns one of the largest oil concessions in the Aquitaine Basin. Esso REP owns and operates four producing fields lying in the heart of the Aquitaine Basin including Parentis, Europe's largest field, Mothes, Lucats, and Lugos.

In 1957, the Aquitaine Basin fields produced more than 10 million bbl of oil which represented nearly 96 percent of all crude oil production from Metropolitan France. Despite a late start in the French domestic oil production scene, the Aquitaine Basin has already produced more than 33 million bbl of oil since the first oil from the basin was discovered on April 23, 1950, on the Lacq Dome west of Pau on the north flank of the Pyrenees Mountains; cumulative recovery from the Aquitaine Basin represents nearly 59 percent of Metropolitan France oil production to date.

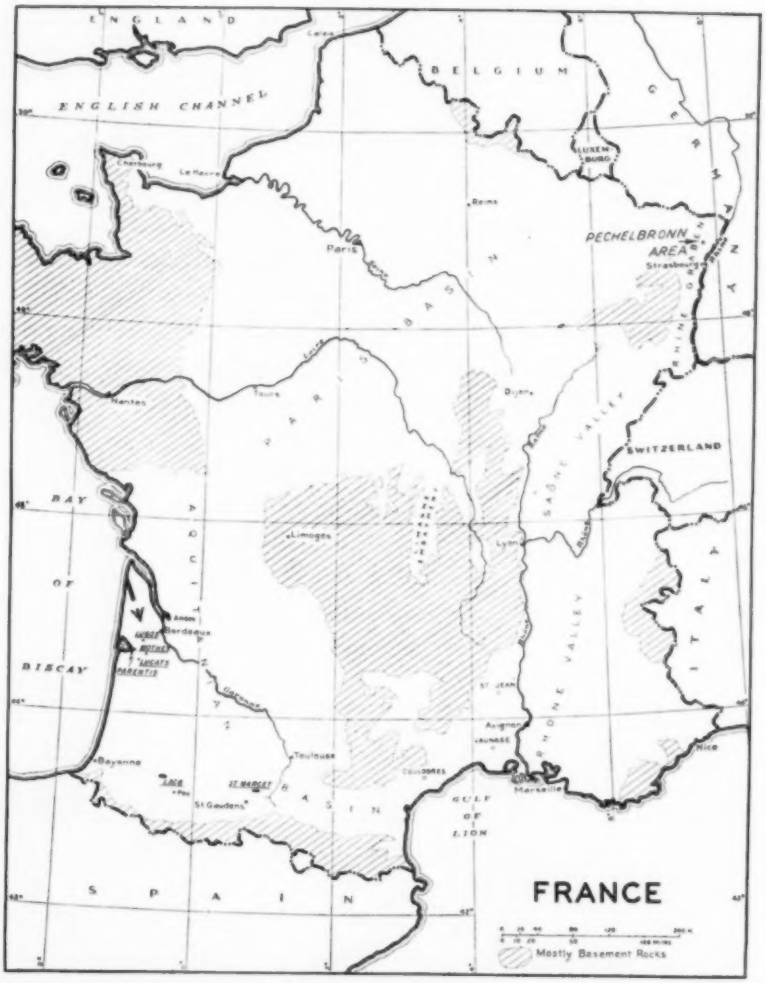

FIG. 1. **The Aquitaine Basin** of Southern France, one of the more promising exploration areas of western Europe, is shown above with producing fields shown by underlined names. Arrow points to Lugos oil field, France's fifth largest oil field in daily oil production rate.

Subsurface Geology

Structure. The Lugos field is an anticlinal structure accentuated by longitudinal faults. The local structure extends for a distance of 2½ miles along an east-west direction; the width of the structure is only ⅝ths of a mile.

The structure is complicated by the

presence of both longitudinal and transverse faulting and by several major unconformities which occur above and below the principal oil reservoir. Flanks are steep and the dips range from 20 to 25 deg.

Regionally, the Lugos structure comprises a portion of an important east-west trend of anticlinal type, faulted on either flank; and the central part of the trend is a horst. This trend extends from Bouglon on the east, to Cazaux on the west, passing through the entire Esso REP exploration area including the Mano and Lugos field wells.

Below the main unconformity occuring at the top of the Albian stage of the Middle Cretaceous system, the Lugos structure is clearly developed. The reversal which occurs between wells 3 and 4 along this axis is clearly seen in transverse geologic sections. The central portion of the structure is uplifted by faults thus forming a horst, a condition apparent between wells 3, 4, and 5 lying within the horst block. (See Fig. 2.)

Stratigraphy. The Quaternary and Tertiary formations dip regularly in this region from east to west; however, a very slight reversal may be observed in north-south cross sections. Thus these systems thicken from 2132 ft in the east to 3280 ft in the west.

The Senonian stage of the Upper Cretaceous is generally thin, varying from 0 to 492 ft and is limited by two unconformities occurring both above and below the formation boundaries. However, the oil-producing structure at Lugos is not reflected in the present attitude of the Senonian stage.

The Cenomian stage of the Upper Cretaceous, on the other hand, *thins* from east to west, ranging from 2559 ft in the east to 1148 ft in the west. A slight reversal may be observed in both longitudinal and transverse sections.

Small unconformities feature both the Albian and Aptian stages of the Lower Cretaceous. The principal oil producing reservoir at Lugos lies in the Aptian stage which is equivalent to the upper oil producing reservoir in the Parentis oil field 16 miles to the southwest.

The interval occupied between the principal unconformity at the top of the Albian stage at Lugos and the top of the first porosity ranges from 787 to 1082 ft as shown in Table 2.

The Neocomanian stage of Lower Cretaceous, which corresponds to the lower and main part of the Parentis oil reservoirs, is represented by dolomite in the Lugos field and lies generally close to the field oil-water contact. The producing sandstones of the Lower Aptian stage at Lugos rest unconformably on the Neocomanian rocks.

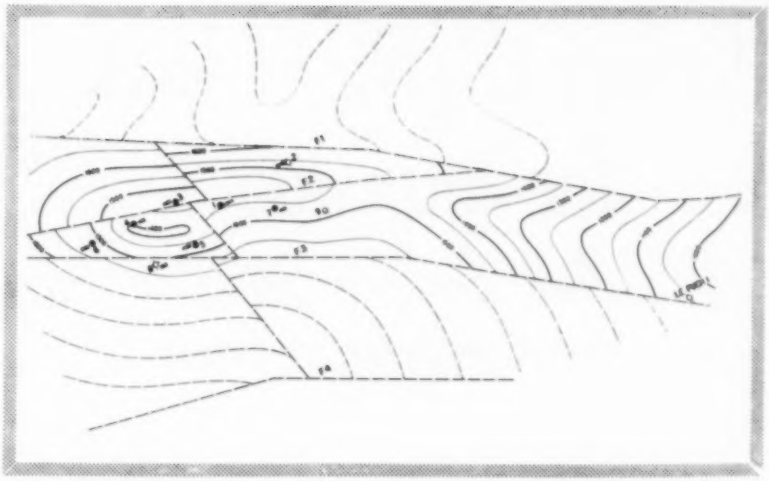

FIG. 2. **Subsurface structure contour map** of Lugos oil field, latest developmental area in the active Aquitaine Basin of southern France. Contours mapped on top of the R1 Zone. Datum plane: Mean sea level. Contour interval: 50 meters. Scale: 1/20,000.

Reservoir Characteristics

Lithology of the oil producing reservoir at Lugos ranges through sandstones, sandy limestones and dolomite. The oil column attains a maximum of 600 ft, ranges from as high as 4900 ft in Lugos 4 near the crest of the structure to as low as 5500 ft at the base of the porosity in Lugos 1 which also lies in the horst sector of the field.

Development History

Commercial oil production was established on the Lugos structure on September 3, 1956, with completion of Esso REP Lugos 1, which was drilled on the crest of a reflection seismograph anomaly. Lugos 1 encountered Lower Aptian porosity from 5000 to 5500 ft in drilling to a total depth of 6120 ft in barren Neocomanian dolomite. After treatment with MCA acid, initial production gaged 410 bbl of 20.6 deg API crude oil per day. Lower Aptian sandstone was productive through casing perforations from 5000 to 5500 ft.

The first offset, Lugos 2, encountered the top of the R-1 zone at a subsea depth of 5079 ft on the downthrown side of an east-west longitudinal fault; it was 341 ft structurally lower than the same datum in the discovery well which found the top of the R-1 zone at 4738 ft.

The second producing oil well was not completed until April 12, 1957, when the northwest offset to the discovery well, Lugos 3, was completed for an initial oil rate of 165 bbl of oil per day, through casing perforations from 5050 to 5430 ft.

Development continued in a generally east-west direction throughout the central horst sector and four additional oil wells were completed between April 12, 1957, and May 14, 1958.

Presence of the south boundary fault of the central horst sector was revealed by drilling on June 12, 1958, with completion of a dry hole at Lugos 8 which found the top of the R-1 zone at a depth of 5299 ft; this compared 483 ft structurally lower than Lugos 5, a producing oil well in the central horst which found the top of the R-1 zone at 4816 ft.

TABLE 1. Oil Production from Aquitaine Basin Field During 1957.

Field	Operator	1957 Production	Cumulative Oil Production to 1-1-58
Parentis	Esso REP	8,773,400	20,962,000
Lacq (Upper Pay)	S.N.P.A.	1,180,475	12,199,000
Lugos	Esso REP	120,130	157,342
Mothes	Esso REP	115,093	311,320
Lucats	Esso REP	12,453	14,389
Total Aquitaine Basin fields		10,201,551	33,644,051
Total Aquitaine Basin fields Percent of all France		95.81	58.64
Total France		10,647,467	57,366,578

TABLE 2. Variation in Interval From Top of Albian Stage to Top of Porosity in the Lugos Oil Field, Aquitaine Basin, France.

Well	Status	Structural Position	Interval from Top of Albian Stage to Top of Porosity ft.
4	Oil Well	Crest of horst	787
West of 6	Oil Well	West flank of horst	1,083
2*	Dry hole	Northeast of horst	1,312*

*The Aptian zone is oil barren in this well due to its structural position on the north downthrown side of the central horst, placing it below the oil-water contact.

Drilling Practices

Medium-depth rotary drawworks are employed in development of the Lugos field. Prime movers are two 550-hp

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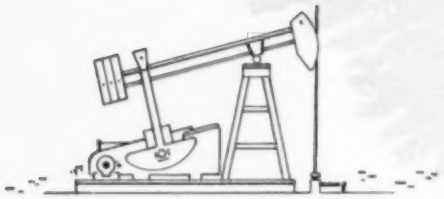

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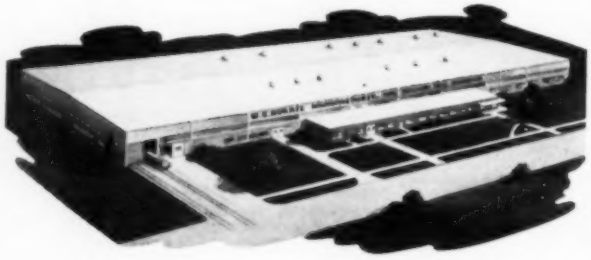

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internal combustion engines. The mud system is handled by two mud pumps, one 600-hp and a 350-hp 7¼ by 14-in. unit.

The 129-ft by 24-ft 498,000-lb capacity derrick is mounted on a 9-ft 8-in. open-face substructure.

Contractor cuts a 20-in. hole to a depth of 130 ft and sets a string of 16-in. conductor casing which is cemented to the surface with 200 sacks of quick-set cement. The conductor shoe is then drilled and a 15-in. hole cut to a depth of 650 ft where the protection casing of 11¾-in. pipe is cemented with 720 sacks. After the shoe is drilled, the hole is reduced to 8¾-in. and this size borehole is cut through the Lower Aptian oil reservoir to an average depth of 5500 ft. The production string of 5½-in. pipe is set on the base of the porosity and cemented with 650 sacks.

Overall penetration rates range from 148 ft per day in Lugos 5, to as high as 282 ft per day in Lugos 3, both oil producing wells.

Mud program. In cutting the hole for the conductor pipe, bentonite mud with ruffages was employed, and a marsh-funnel viscosity of more than 100 sec API was maintained while drilling through the Quaternary and Tertiary beds. In drilling the interval from the base of the conductor pipe to the depth of the casing seat for the protection pipe, red mud with bentonite, quebracho and caustic soda with CMC were used with ruffages added at the rate of 10 lb per bbl of mud; marsh funnel viscosity was maintained over 100 sec, API. In drilling the remainder of the hole into the oil reservoir, a CMC red-type drilling mud was used including CMC, bentonite, quebracho and caustic soda; marsh-funnel viscosity was lowered to from 45 to 50 sec and the pH value was held at 10. Water loss was held from 20 cc per 30 min at the top to 10 cc per 30 min at the bottom of the hole.

Coring practices. Considerable coring, principally the diamond type, was employed in drilling the first four wells at Lugos. As many as 39 cores were cut in the course of drilling the discovery well, Lugos 1; of 39 cores 27 were cut in the Lower Aptian oil reservoir. Out of the total number of cores cut in this well, 25 were diamond cores with a recovery factor of 90 percent. Coring was conducted frequently in Lugos 2 (dry hole), Lugos 3 and 4 (oil wells), with nearly all of the coring confined to the oil-producing reservoir; these comprised from 14 to 15 cores per well.

However, in development of the last three drilled oil wells — Lugos 5, 6, and 7 — all coring was limited to the diamond type and these ranged from 14 to 65 ft total per well. Diamond core recovery was 100 percent in Lugos 5 on a single 14-ft core as compared to 93 percent in Lugos 6 and 60 percent in Lugos 7.

TABLE 3. Hole Size, Casing and Cementing Practices, Lugos Oil Field, Aquitaine Basin, France.

String	Hole Size (in.)	Casing String OD (in.)	Seat (ft)	Cement Sacks
Conductor	20	16	130	200†
Protection	15	11¾	650	720
Production	8¾	5½	5500 (T.D.)	650

† Quick-set cement.

Completion Operations

The following standard procedures are being employed currently in completion operations in the Lugos field. After the 8¾-in. bore hole is cut through the oil-producing reservoir to an average depth of about 5500 ft, the well is subjected to a series of well surveys including resistivity log, a combination SP gamma ray and neutron log; a caliper log, a MicroLog and a DipLog for deviation.

The 5½-in. oil string is then run to bottom and cemented with 650 sacks of portland cement. After setting time has elapsed, the casing is then pressure-treated to 1500 psig. The cement is then drilled through the casing shoe. Drilling mud is then circulated out by reverse circulation using Lugos lease crude.

A 3⅜-in. diameter perforating gun is then lowered into the hole to its position opposite the oil producing reservoir. Perforation density practice is 4 shaped charges per foot. The range of producing section perforated in a single well was 500 ft in the discovery well — Lugos 1 — where 636 shaped charges were detonated. However, this practice is unusual at Lugos, and the customary method is to employ from 156 to 168 shaped charges per well.

The well is then tested through the casing after packer with disc valve is run; the well is then swabbed from different depth levels. After the well is cleaned up, it is shut in and a bottom-hole pressure bomb run for a series of pressure tests to establish the build-up curve characteristics of the well for reservoir evaluation. After this work has been completed, the bomb is pulled and the well tubed with a string of 2⅜-in. tubing which is equipped with conventional pump-barrel and anchor. A string of sucker rods is run and the well is then placed on the pump.

TABLE 4. Diamond Coring Practice.
Lugos Oil Field, Aquitaine Basin, France.

Well	1	2	3	4	5	6	7	8
Type	Producer	Dry	Prod.	Prod.	Prod.	Prod.	Prod.	Dry
Number of cores	39	14	15	16	1	4	2	—
Number of cores in reservoir	27	12	15	14	1	4	2	—
Length of cores in reservoir ft.	830	610	465	480	14	65	50	—
Conventional cores	14	1	1	3	0	0	0	—
Diamond cores	25	13	14	13	1	4	2	—
Recovery factor	0.9	0.94	0.98	0.89	1	0.93	0.60	—

TABLE 5. Completion Summaries.
Lower Aptian Sandstone Oil Reservoir
Lugos Oil Field, Aquitaine Basin, France.

	Lugos 1	Lugos 2	Lugos 3	Lugos 4	Lugos 5	Lugos 6	Lugos 7	Lugos 8
Top of porosity, ft	5000	—	5050	4900	5150	5350	5300	—
Base of porosity, ft	5500	—	5450	5400	5350	5450	5440	—
Production casing-seat, ft	5550	—	5430	5300	5370	5450	5450	—
Range of producing perforations, ft.	5000–5500	—	5050–5430	4900–5300	5150–5350	5350–5450	5300–5440	—
Shot density charges/ft	4	—	4	4	4	4	4	—
Number of charges	636	—	360	280	204	168	156	—
Acid treatment	MCA	—	No	No	No	No	No	—
Initial production rate/bbl/day	410	dry	165	240	160FL	45	130	dry
Completion date	Sept 3-56	Nov 26-56	April 12-57	July 26-57	Dec 6-57	March 22-58	May 14-58	June 12-58
Produced gas-oil ratio, cu ft/bbl	0	—	0	0	0	0	0	—
Produced gravity of crude oil deg API.	20.6	—	20.6	20.6	20.6	20.6	20.6	—

Pipeline Outlet

Oil is now trucked from the Lugos battery to the Parentis field battery 16 miles to the southwest for treatment and for subsequent delivery to the 12-in. crude oil trunk line extending from Parentis field to Ambes terminal southwest of Bordeaux. During 1959, a 6-in. gathering line will be constructed from the Lugos field battery to tap the Parentis-Ambes trunk line.

At present, oil is shipped by tanker from the Ambes terminal to the Pointe Ste. Jerome refinery on the north coast of France for processing. However, an Esso refinery is under construction at the Ambes terminal to process the crude.

Acknowledgments

The writer extends acknowledgment to the following for data and for permission to publish this article: Dr. Siro Vazquez, coordinator of the producing and coordination department of the Standard Oil Company (New Jersey), A. Dubois, Begles (Gironde,), France, Esso REP, and to James Crayhon, public relations department, Standard Oil Company (New Jersey). ★ ★ ★

WATERFLOOD WATER SUPPLY SYSTEM in Denver-Julesburg Basin

Oil producer cooperation in five Eastern Colorado fields permitted fast construction of modern system, now providing 50,000 bbl of water per day to five fields

Robert L. Hoss
Vaughey and Vaughey
Denver, Colorado

A RAW WATER delivery system with 50,000 bbl per day design capacity is now being operated by Vaughey and Vaughey in the Denver-Julesburg Basin of Eastern Colorado, supplying water to five fields for waterflood purposes. Two more fields plan to begin taking water from this system by June 1, 1959.

Although favorable waterflood potential of oil fields in the southern end of the Denver-Julesburg trend was realized over three years ago, the absence of adequate volumes of local water at reasonable depths precluded the planning of projects.

In response to the water need, Vaughey and Vaughey initiated a water prospecting effort, which by October 1956, had resulted in the development of adequate fresh water reserves at a location eight miles southeast of Brush, Colorado, and 24 miles northeast of the principle oil producing area.

Interest and support of potential water users was immediate and almost unanimous. Therefore, a water supply system was planned in close cooperation with the using companies who in turn began estimating their water needs and planning projects.

Construction of the water system was commenced June 2, 1958, and completed about September 1, 1958.

Water delivery began September 19, 1958, to the Little Beaver East Unit, operated by Lion Oil Division of Monsanto Chemical Company and to Badger Creek and South Kejr Unit projects, operated by Sinclair Oil & Gas Company. The Little Beaver "D" Unit project operated by Continental Oil Company began taking water October 14, 1958. The Kejr project operated by Sohio Petroleum Company began taking water on January 8, 1959. At present demand, the system is supplying approximately 47,000 bbl per day.

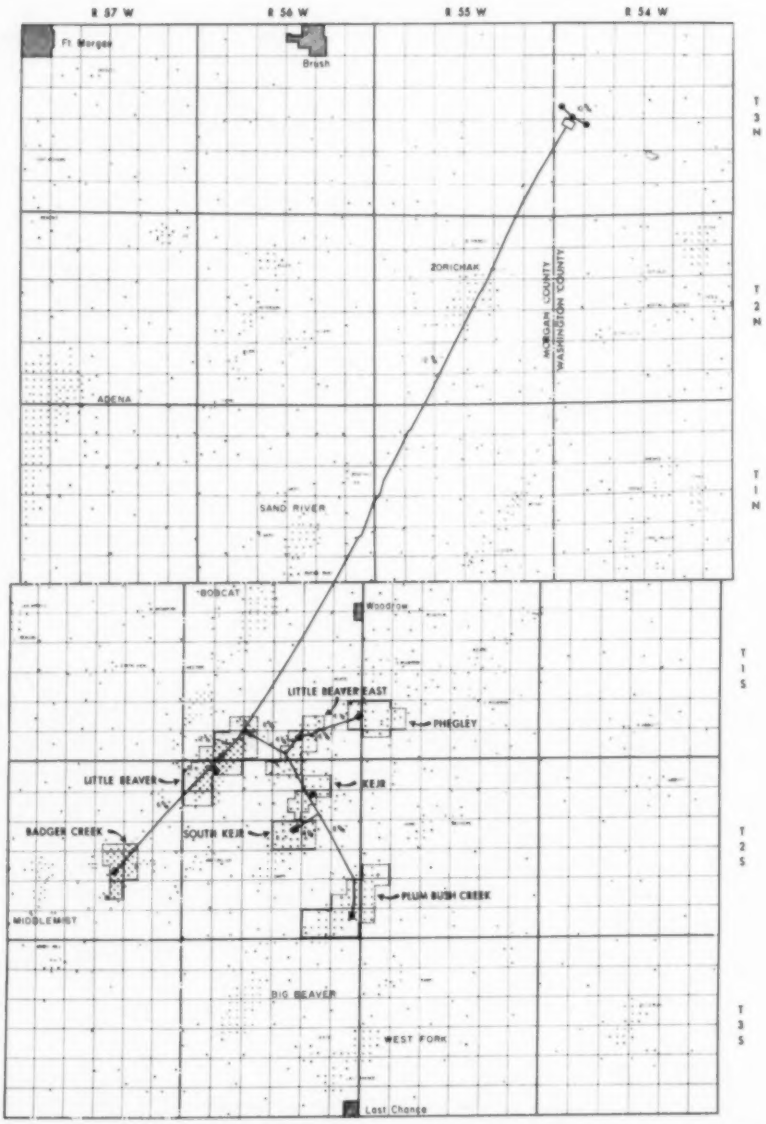

FIG. 1. **Pipeline** in Vaughey and Vaughey's water supply system stretches 49 miles in Morgan and Washington counties, Colorado. Five fields are now making use of the water. Construction is now underway to link the two most easterly fields, Phegley and Plum Bush Creek, into the system.

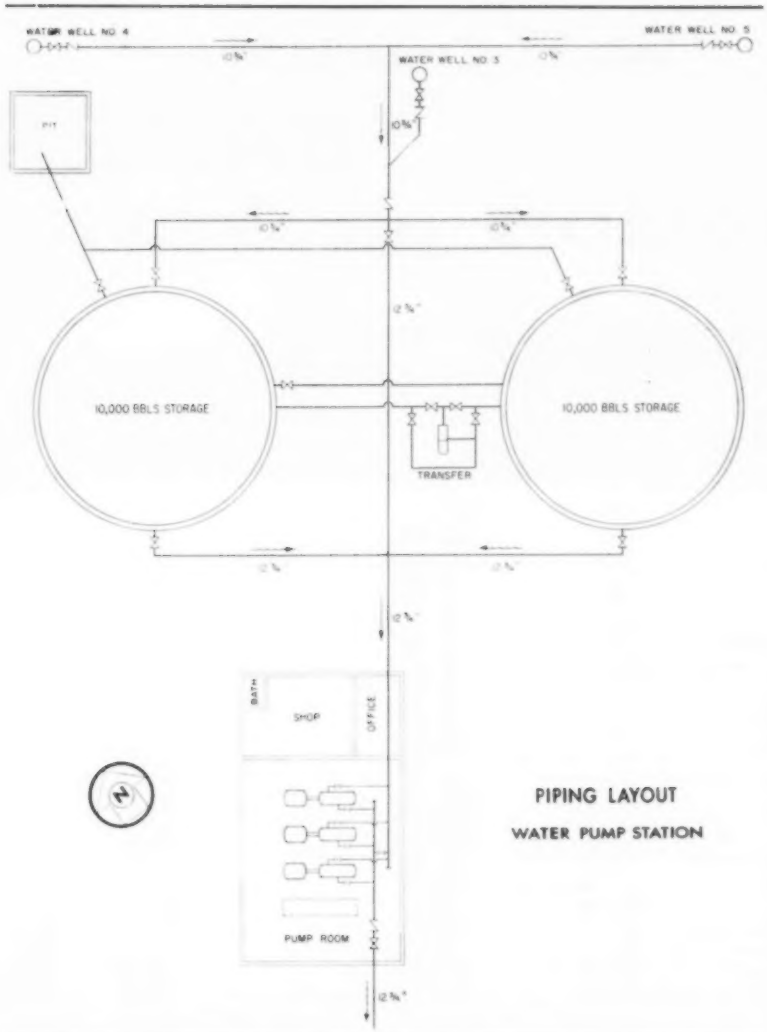

FIG. 2. **Pump station piping layout.** The three water wells are remotely operated and controlled from the station. High and low level controls on the two storage tanks actuate water wells and plant pumps.

Future Demand

Two additional projects will begin taking water on completion of facilities. These will be the Plum Bush Creek Unit operated by Continental Oil Company, and the Phegley Unit operated by Champlin Refining Company. As system capacity permits, it is anticipated that other major fields in the area may also undertake water injection operations.

Water Supply

The water source is a shallow alluvial deposit of sand and gravel of Pleistocene to recent age.

Three water wells 100 ft deep were completed on one-half mile spacing, each equipped with a 40 hp electric motor and a centrifugal pump having a capacity of 30,000 bbl per day. These wells deliver water to the centrally located pump station through a 10¾-in. gathering system.

Pipeline

The pipeline system shown in Fig. 1. consists of 49 miles of line varying in size from the 12¾-in. trunk to 4½-in. delivery laterals. All line was doped, wrapped, and buried with a minimum of four feet of cover. Block valves permit isolation of the trunk line and two main branches. An elevation rise of 352 ft must be opposed from the pump station to the southeastern end of the system.

Pump Station

The pump station, located at the water source, consists of two 10,000 bbl bolted tanks for surge and storage and three six-stage centrifugal pumps in parallel, each driven directly by 250-hp, 2400-v, 2600 rpm electric motors. The pump station piping layout, shown in Fig. 2, is simple and effective in providing adequate storage and suction head for the pumps.

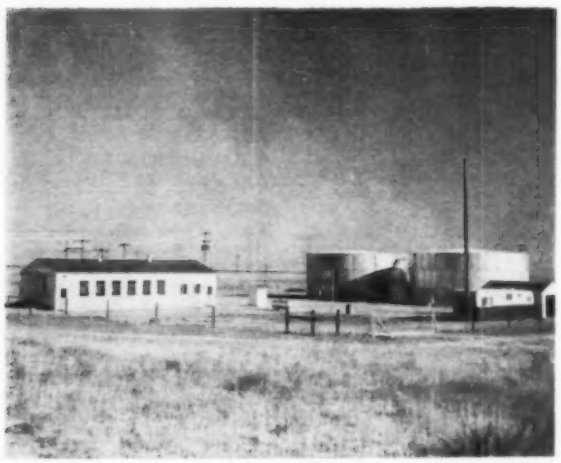

FIG. 3. **Pump station site,** near Brush, Colorado. An office and shop are maintained in the main pump house. Between the two storage tanks is the tank transfer house.

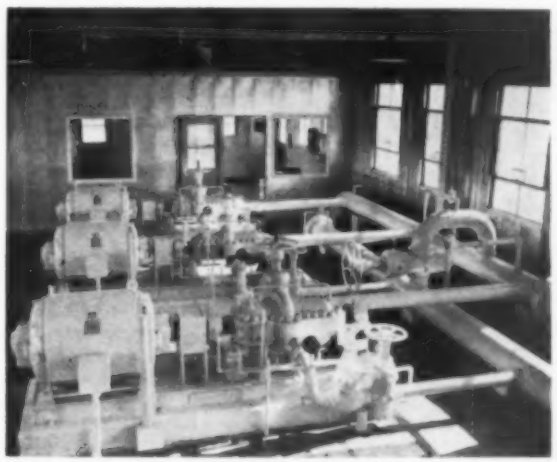

FIG. 4. **Three main pumps** are six-stage units operating in parallel, each driven by 250-hp 2400-v electric motors.

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PRODUCT NO. 415-FA

Related to the Model "F" Packer in the same manner that the Model "DA" is to Model "D." Contains extra large upper sealing bore. Provides largest I.D. of any retainer-type packer. Used primarily in multiple string hook-ups.

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PRODUCT NO. 694

Used as the upper retrievable packer in two-packer pumping hook-ups involving dual-zone pump. Set and released in same manner as Cross-over Snap Set packers above.

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One of the shortest, most modern high-performance tension packers. Ideal for economical low- or high-pressure water flooding. Rugged enough for many high-pressure fracturing and acidizing operations. Simple J-Slot setting mechanism.

All water wells are remotely operated from the station, with automatic control through timeclocks. Water wells and plant pumps are automatically shut down by high and low level controls on storage tanks. The plant centrifugal pumps are protected by automatic motor shutdown devices from operating with no line flow, excessive vibration, or packing failure.

Water Measurement and Delivery

All water is measured by conventional orifice meters at the plant suction and at each delivery point. Measurement by this method has been very satisfactory, with less than 1 percent error when proved against storage vessels.

Water is delivered at one point in each field, usually at the site of the field treating and pumping plant. Deliveries are made at 50 psi line pressure or higher and are delivered at constant volume.

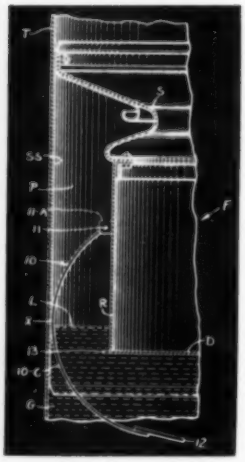
The local water shortage existed. A remote supply was found from which water could be delivered to the producing area at economical rates, provided a sufficient aggregate water demand could be developed. The realization of

FIG. 5. **A water metering station,** located at each of the five existing delivery points. Each house contains conventional orifice meters, which have been proved better than 99 percent accurate.

this water supply system is the result of complete cooperation and support of all oil producers in the fields being served.

Acknowledgment

Acknowledgment is made to Vaughey and Vaughey, and to resident partner W. T. Blackburn for permission to publish this report. Special mention must be made of W. D. E. Cardwell of the United States Geological Survey for the discovery of the water source, of J. R. Wait, Jr., of Texas Brand Pipe Lines for line and plant design and consultation during construction, of Sterling Construction Company for line construction, and of Stearns-Rogers Manufacturing Company for plant construction. ★ ★ ★



Patents

Marvin R. Jones
Consulting Engineer, Houston, Texas

LAST SPRING someone said to me, "Your company's products cost us twice as much as they should because of all those patents you have. We think you ought to give them all to the public."

Before then, it had never occurred to me that such an outlook on the American patent situation existed. Since then, many remarks have seemed to show that few engineers and executives understand our patent laws and their purpose.

The concept of giving grants of monopoly started with various kings who felt they had the right to take over — for the sole benefit of themselves or their friends — whatever part of their country's trade and commerce they chose. Widespread public resentment resulted from the ensuing oppressive privileges. A feeling arose that no government should be able to grant any kind of a bar to free trade which did not benefit the public as a whole.

In England, this thinking found its way into law in 1623 with the passage of the famous "Statute of Monopolies." This law ended all grants of monopoly except those made in reward of invention and discovery.

Its first purpose was to induce anyone who had a secret which was new and useful to the public to tell the public about it, and thereby add something to the common fund of useful knowledge.

Secondly, it hoped to get people to spend money and time working on inventions and discoveries which they could not hope to keep secret. It thought that rewarding inventors, in relation to the value of the knowledge they gave to the public, would do this.

Our Patent Statutes

In our constitution, writers tried to put all of the progress of European governments into the part which gave our government the right to grant patents and copyrights. The patent statute and later laws carried out the constitution's intent. Also, court decisions on patent law suits began to build a base in law for measuring the things not defined by the laws congress passed.

During this time, our statesmen reasoned:

Prosperity demands progress.
Progress requires the development and distribution of knowledge.
Without pay, people won't work to find new areas of knowledge and give them to the public.

Or, saying it another way, creating an incentive for private research and public disclosure gives better results than we could get from a socialistic program of government supported and directed research.

Legal Problems

Unless the laws succeed in benefiting the public first and most, they fail to do what the constitution intended for them to do. Let's take a look at some of the problems lawmakers have run into and see how they have tried to deal with them.

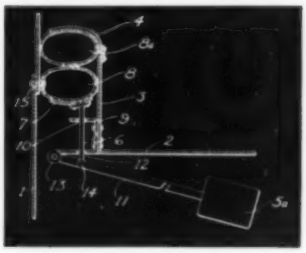
Suppose for example that you have used some tool or procedure for years. What keeps someone from getting a patent on it and telling you to stop using that tool or that procedure?

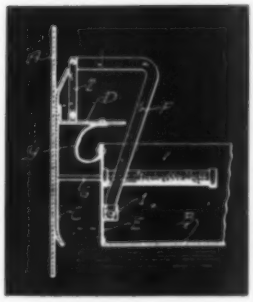
If your use has been public, then you have given knowledge of that tool or process to the public. Once the public has had legal right to the use of such knowledge, the law does not intend for something to take that right away. So, it does not let anyone take out a patent for an invention made public more than a year before he filed his patent application.

On the other hand, suppose you perfect a tool and make a successful effort to keep it secret. Then, some other person with the same idea may be entitled to a patent for his willingness to tell the public about his invention, as shown by his filing a patent application.

Do Affect Costs!

Product patents cut drilling and production costs, if not, you have no reason paying for them





Invention

The law further requires invention for a patent. Just any new design or process will not amount to invention. It needs certain specific qualities.

To get a patent, an idea has to be new. As far as the public is concerned, the inventor must be the first one to think of the idea as far as he knows.

Then, the idea should have usefulness. Although the law thinks that a patent on a poor idea has little value, a patent office examiner could refuse to grant a patent on a plainly useless idea.

In addition, the idea cannot be an obvious one. If most men skilled in the trade or art to which the idea relates would come up with the same idea when faced with the same problem, an examiner might likely think it obvious. Then, unless he felt that it took invention to understand the problem, he would probably say the idea did not amount to invention.

Patent examiners study each patent application very carefully for newness and lack of obviousness. They insist that the application explain the nature of the problem the invention solves. Then, it must explain how the invention solves this problem so plainly that any skilled person can use the invention after studying the patent. Before the examiners let the application issue, they make the applicant give up any claim to everything already belonging to the public.

After the patent office grants a patent, a federal court can declare it invalid. Courts sometimes do this in the course of patent suits if evidence shows that the patent office made some mistake, or that it failed to find all the evidence bearing on the invention.

You may wonder again about what would happen to you if you suddenly met a new problem in your business. You solve this problem with some new tool or a new method. Since the answer seems plain enough to you, and since you know that others have done about the same thing you did, you don't think about a patent. What keeps someone else from getting a patent on your idea?

The Obvious

In such a case, the fact that several people faced with the same problem soon came up with about the same answer tends to show that the answer fell within the limits of normal skill in that art. The patent examiner could, in most cases, show that this solution only combined parts of two or more patents already granted with results that practically everyone in the business would expect. In some cases, he might need to refer to advertising or printed articles, or to principles handed down in court decisions to make his point.

In the other extreme, a problem may exist for a long time, form a real obstacle to progress, and resist intensive efforts toward solution. These facts form strong evidence that the final answer is not obvious.

Due to our human, built-in 20-20 hindsight, most inventions seem obvious after someone makes them. Knowing this, court decisions have gone into great detail on the problem of measuring how obvious an idea may be. Some of the principles they set out form the principal gage of invention.

None of the laws passed by congress actually defines invention. For this reason, the patent office guides its actions in part by rules taken from generally accepted court decisions.

You may agree that patent law has complex problems and that some great minds have worked out good ways to deal with those problems. You may concur with the aims of our patent system. But, you may wonder how anyone can measure how much good the system does.

The wealth of American invention and the attendant material progress of our country best gages the success of the system in inducing people to make invention and give it to the public. American industry's plans to spend between eight and nine billion dollars on product research in 1959 means that incentive still exists.

Compare our record with that of other nations. Consider that our system does not limit the number of solutions to any single problem. Consider that the owner of an American patent can only exclude the public for a limited period from the use of knowledge that it did not have before the invention. Then, it becomes plain that the system has given us great benefits for sound reasons.

Research Costs Money

Of course, any company which spends millions of dollars on product research counts that money as much a part of product cost as it does labor, steel, or rubber. People who buy products from such companies pay for research as well as the other costs.

Product patents cannot take away from you any privilege you had. They cannot stop you or others from finding your own answers to problems. So, they obviously cannot add to your drilling and producing costs.

If patented features do not cut your costs or give you some other benefit, you have no reason for paying extra for products which include these features. ★ ★ ★

Only Known Motor Specifically Designed for Oil Well Pumping
HIGHEST MOTOR SLIP lets counterweight inertia absorb the shock of the rig's sudden peak loads—not the motor!
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NEW GENERAL ELECTRIC TYPE KOF MOTOR NOW MAKES POSSIBLE . . .

Lowest Oil Well Pumping Cost Per Barrel; Dependable, Unattended Rig Starting

General Electric's new Type KOF motor is the only known motor designed specifically to handle the unusual load demands of oil well pumping rigs!

Eight- to ten-percent slip—highest of any oil well pumping motor—lets the rig's inertia smooth out load and current peaks that often damage ordinary motors and cause voltage fluctuations. This means lowest kw-hr cost per barrel pumped!

Four-hundred-percent (400%) starting torque gives General Electric's new Type KOF the extra power needed for dependable starting on unattended rigs. Highest starting torque prevents stalling and costly motor burnout!

No other motor has been designed so completely around the requirements of the oil well pumping application. For the full story call your authorized motor distributor or nearby Apparatus Sales Office; or write direct to Section 899-4, General Electric Co., Schenectady 5, N. Y.

Compare General Electric's New Type KOF Motor

	Starting Torque	Motor Slip	Double-end Ventilation	762-volt Connection	Regreasable Design
General Electric (Beam-type Pumping Motor)	High	8-10%	Yes	Yes	Yes
Manufacturer "A" (NEMA C)	Low	2-3%	No	No	No
Manufacturer "B" (NEMA D)	Med.	5-8%	Yes	No	Yes
Manufacturer "C" (NEMA D)	Med.	5-8%	No	No	No

Progress Is Our Most Important Product

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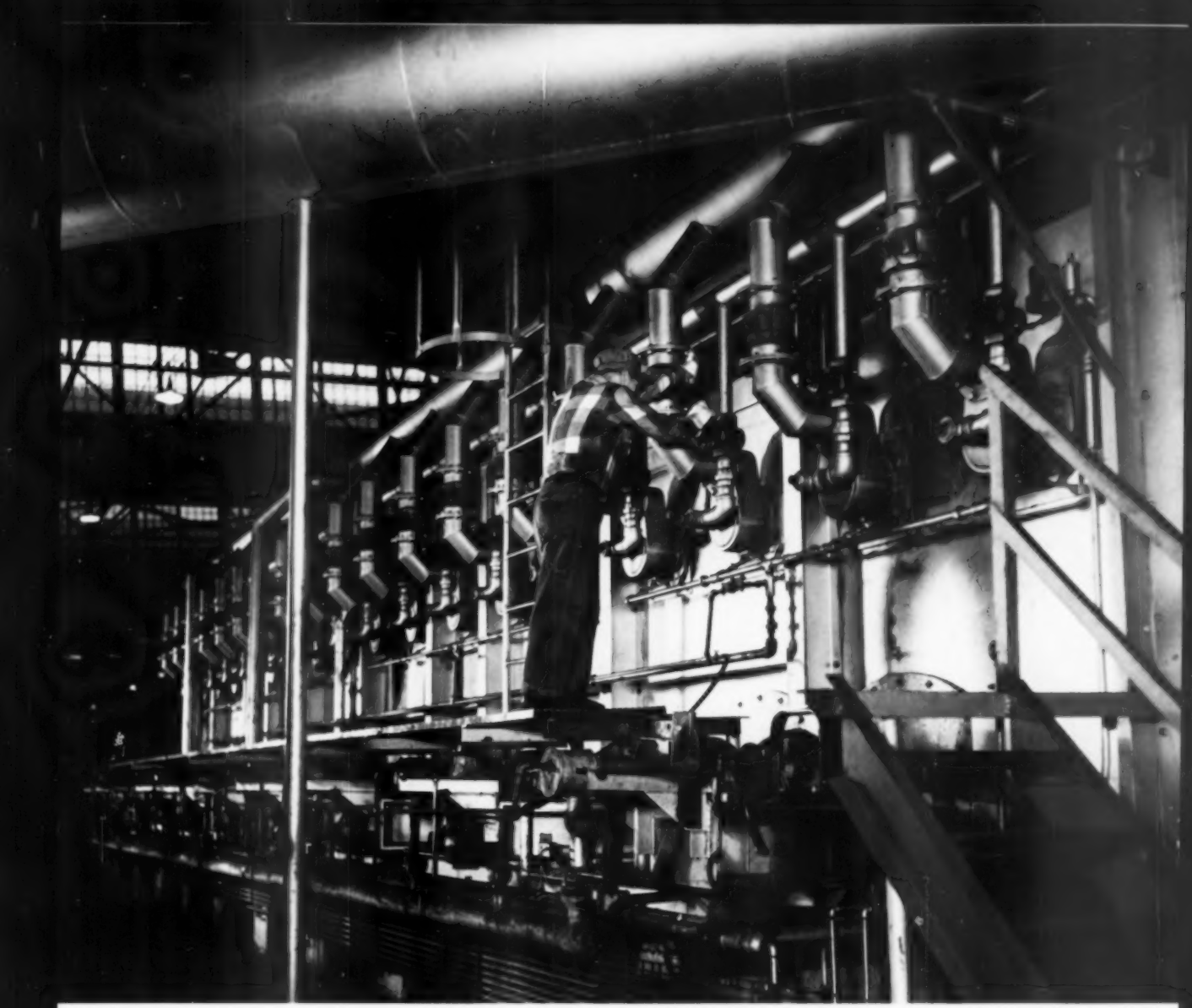


Side view of National's new 56'3" x 52' walking beam furnace. The action of this furnace insures the most uniform heat possible on SPANG tubular products.

It looks like more SPANG customers to us!

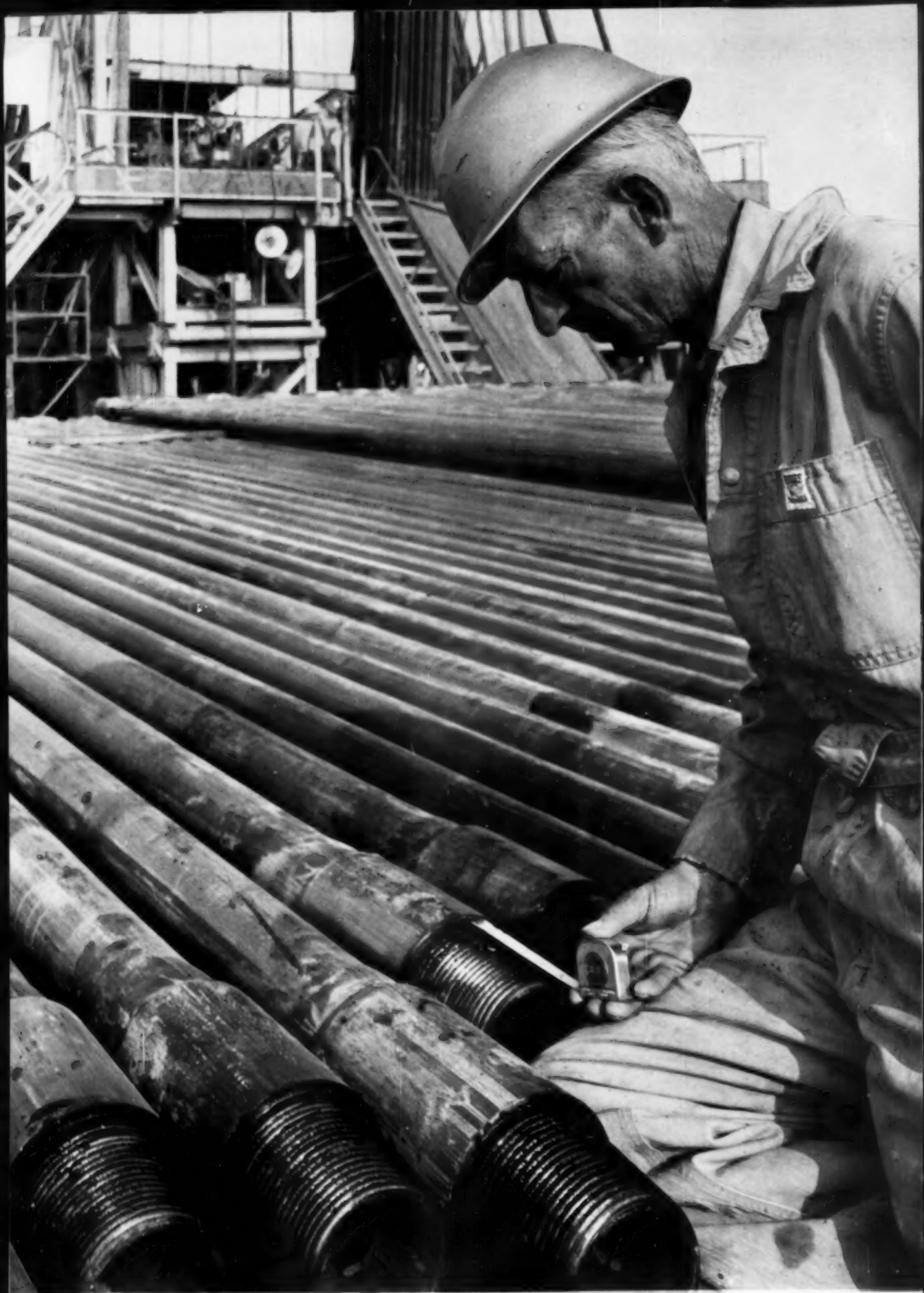
THE NATIONAL SUPPLY COMPANY NSCO

This is the new walking beam furnace installed in our Ambridge, Pa. plant. By handling 35 tons of SPANG tubular products every hour, it substantially increases our tempering and normalizing capacity.

There are many ways to regard a new plant facility. The way we look at it is this: Whether it's a furnace, a tester or any other piece of equipment, more capacity and better control of quality mean an increase in satisfied customers. National's line of SPANG tubular products is the most dependable you can buy.

On the next pages:

SPANG Drill Pipe and Tool Joints



However you measure it,

a SPANG drilling string gives you the best service!

There are three main reasons why SPANG drill pipe consistently outperforms any other—by any standards of measurement:

1. A SPANG drilling string is a fully integrated string.

National Supply is the only company in the industry manufacturing both the drill pipe and the tool joints. From this *single* responsible source, you get a string that has carefully controlled quality from start to finish.

2. SPANG leads in tool joint design—the critical area of pipe service life.

Spangweld Tool Joints are welded to the drill pipe by an automatically controlled operation insuring accurate alignment and a high quality weld. The welding permits a streamlined contour and a reduced number of threaded elements. This tool joint connection also allows the smallest practical O.D. and maximum bore —a definite advantage for slim hole drilling.

Spang Double Seal Shrink Thread Tool Joints can be easily removed and replaced in the field. Joint design has an outer seal, threads and inner seal all on a single cone. This insures uniform, reliable installations both at the mill and in the field, and completely seals against internal and external pressures.

3. SPANG provides the best selective protection against corrosion and abrasion.

Spang Plastic Coating—the result of ten years of research—gives the best protection against corrosion. Scientifically applied at the mill on specially-developed facilities, SPANG Plastic Coating is available not only in SPANG Drill Pipe but also SPANG Casing, Tubing, and Line Pipe.

Spang Hardfacing is a superior protection for tool joints in abrasive formations. It consists of multiple bands of tungsten carbide, *continuously* overlapped on the joint to form a solid particle-to-metal band.

Specific proof of these reasons is furnished every day in numerous locations throughout the world. The National representative in your area will be pleased to tell you more.

SPANG DRILL PIPE—Sizes and performance properties for every requirement

(All properties are based on pipe body)

DRILL PIPE				COLLAPSE			TENSION			INTERNAL PRESSURE		
Size OD	Weight per Foot (Nominal)	Wall	ID	Minimum Resistance Pressure			Minimum Yield Strength			Fibre Stress=87½% of Minimum Yield Strength		
				Grade D	Grade E	Grade G†	Grade D	Grade E	Grade G†	Grade D	Grade E	Grade G†
Inches	Pounds	Inches		PSI			1000 Lbs.			PSI		
2⅞	10.40	.362	2.151	10730	13210	18980	157	214	300	12120	16530	23140
3½	★ 9.50	.254	2.992	—	8080	11610	—	194	272	—	9530	13340
	13.30	.368	2.764	9170	11290	16230	199	272	380	10120	13800	19320
	15.50	.449	2.602	10900	13420	19290	237	323	452	12350	16840	23570
4	★11.85	.262	3.476	—	7080	10170	—	231	323	—	8590	12040
	14.00	.330	3.340	7380	9080	13060	209	285	400	7940	10830	15160
4½	★13.75	.271	3.958	—	6280	9030	—	270	378	—	7900	11070
	16.60	.337	3.826	6760	8310	11950	242	331	463	7210	9830	13760
	20.00	.430	3.640	8420	10370	14910	302	412	577	9200	12540	17560
5	★15.00	.296	4.408	—	6130	8810	—	328	459	—	7700	10880
	19.50	.362	4.276	6550	8060	11590	290	396	554	6960	9500	13300
5½	21.90	.361	4.778	5770	7100	10200	321	437	612	6320	8620	12060
	24.70	.415	4.670	6800	8370	12040	365	497	696	7260	9900	13860

★ Weights are listed as tentative by API. †Grade G is 105000 psi Minimum Yield Strength Material

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International Petroleum Exposition

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More on the next page . . .

Gathering line service is one of the many oil field applications for dependable SPANG CW Steel Pipe. In addition to gas, oil and water lines, you can use it for roof rails, step rails and many other structural purposes.

There's no premium price for the special quality of SPANG CW STEEL PIPE!

Careful manufacturing control is the main reason why SPANG CW is your best selection for a wide variety of piping installations.

Rigid tests and inspections during manufacturing and before shipping guarantee long service life for SPANG CW Pipe. Every length of SPANG CW Steel Pipe is hydrostatically tested and inspected for thread quality and uniformity. The result is that you get a stronger, more durable pipe with cleaner welds and smoother finishes —inside and outside.

The best part is that you pay no more for this special quality. All sizes of SPANG CW—plain end, or threaded and coupled—are readily available through your nearest National Supply Store. Order now for your next job!

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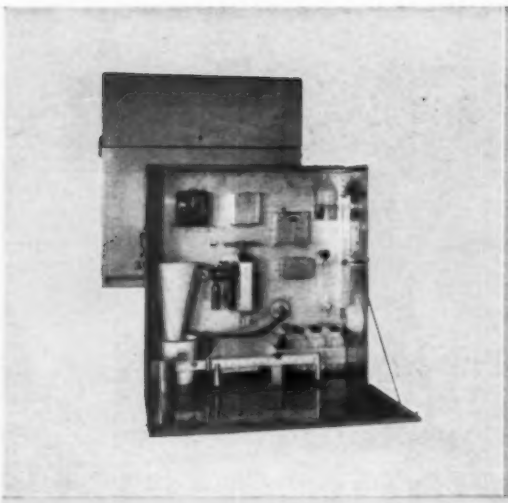

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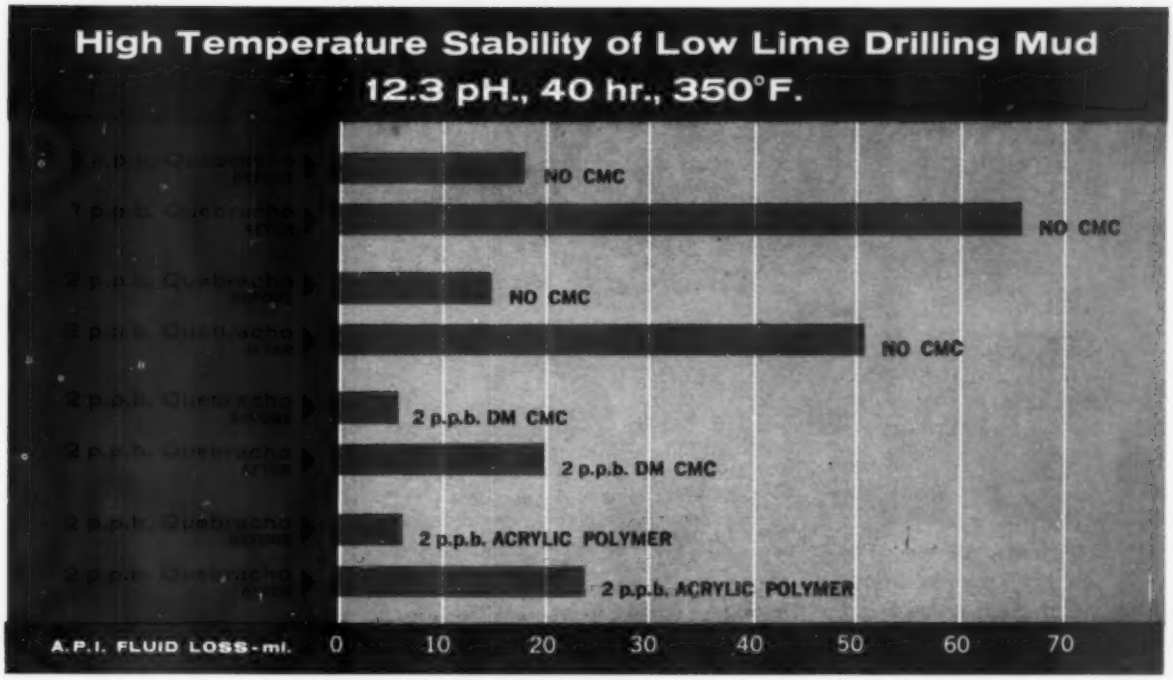


DuPont research shows how to improve the stability of CMC muds at 350°F.

A series of tests conducted as part of our program to study the high-temperature properties of drilling muds showed that at a starting pH above 12 the fluid loss properties of a CMC solution could be maintained, if the oxygen content of the solution was kept low.

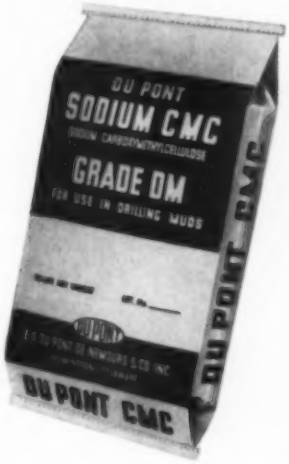
Taking off from there, our researchers added various stabilizers to CMC mud systems to determine their effect on the thermal stability of the muds at the high temperatures encountered in deep wells.

Some of the more important results of these tests are shown in the chart above.

These data indicate that through proper formulation you can improve the fluid loss properties of conventional CMC muds when used in the 350° F. range.

There's a great deal more to this research story—including some interesting facts about the high-temperature stability of the clay used in drilling muds.

If you would like all the facts to date, contact your DuPont representative, or write DuPont, Explosives Dept., 2539 Nemours Building, Wilmington, Delaware.



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Better Things for Better Living
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Can We Keep Exploration Alive?

Oil always has been hard to find — today it's just more expensive!

Merrill W. Haas, *Vice President*
Carter Oil Company
Tulsa, Oklahoma

IN THE VAST Rocky Mountain territory, long known as a region of "sheepherder" structures abundantly endowed with oil, it is significant to note the drastic change and trend toward the stratigraphic approach to oil finding.

Such a shift in exploration philosophy is difficult. It cannot be denied, however, that the obvious and favorably situated structural features, relative to basin position, have been pretty well prospected for structural accumulations. Therefore, the advent of the stratigraphic era in the Rocky Mountain region is both timely and necessary. Until this flexibility and adaptiveness ceases in the minds of the explorationists, the industry and the nation have little to fear about our technical ability to find future reserves.

The oil can be discovered! But there are some serious problems! Simply stated, "Can We Keep Exploration Alive?"

Even though today there is a surplus of oil, there are two impelling motives for pursuing an aggressive search for new reserves. First, daily oil consumption in the United States during 1958 is estimated at 9,000,000 bbl. In addition, the estimated daily consumption of gas is equivalent to 5,000,000 bbl of oil converted on a Btu or energy basis. Some forecasters tell us that by the year 1975, United States oil requirements will be on the order of 17,000,000 bbl and the gas demand will be equivalent to 9,000,000 bbl per day.

According to Morgan Davis[1], president of Humble Oil and Refining Company, current availability of oil approximates 10,000,000 bbl per day. Therefore, ample reserves are needed to support the increasing domestic daily requirements during the next 25 years. Secondly, during this period free-world oil demand will increase to 40,000,000 bbl per day. Where these requirements will be found depends upon the economics for oil discovery. The exploratory effort will be concentrated where oil finding costs dictate. Due to the two-power concept that now dominates the world, a major effort is indicated to find a large part of the U.S.A. requirements in the Western Hemisphere. Thus, our technical and inventive ingenuity are to be tested. We are constantly aware, by their actions, of the Communists' attempts to neutralize the oil centers of the free world. Any measure of success on their part jeopardizes our national security. These events emphasize the necessity for a vigorous exploration effort to supplement requirements beyond domestic needs.

Unfound Reserves Remain

We are blessed domestically with abundant potential reserves for which we must search. The Rocky Mountain region in the United States is a land richly endowed with petroleum and has the potential to fully share in the future. A few statistics will illustrate my point. In 1942 the daily average production of oil was 120,000 bbl. This figure amounted to 630,000 bbl in 1957. Gas production increased from 211,000,000 cu ft per day in 1946 to 1 billion cu ft in 1957. From 1942 through 1957 the year-end remaining crude oil reserves climbed from 428,000,000 bbl to 2.8 billion bbl. The year-end remaining gas reserves increased from 2.2 trillion cu ft in 1946 to 8 trillion cu ft in 1957. These figures exclude the state of New Mexico.

Within the past seven years, the territory has had its full share of major oil discoveries. These are Poplar, Cabin Creek, and Pine fields in Montana; the Nesson Anticlinal trend in North Dakota; the Cottonwood field in Wyoming; the Adena field in Colorado; and the greater Aneth area in Utah. Other areas are currently developing. Whether these will expand to become major discoveries, time alone will tell. The bottom of the bucket has not been reached nor have its contents been exhausted. Statistical studies indicate that only about 25 percent of the ultimate oil and gas potential of the territory has been found so far. These figures probably are conservative.

Furthermore, the replacement cost per barrel of crude for the Rocky Mountain province is about the lowest, if not the lowest, in the United States. Replacement cost is the sum of finding, developing and operating costs per barrel. It has been estimated that, including added reserves from future waterflood projects, industry's replacement cost per net barrel of oil was 43 cents in 1942.[2] It reached a record high of $2.44 in 1954. In 1957, the replacement cost declined to $1.73. The average for the years 1942 through 1957 was $1.34.

Where Is the Oil?

Where and how will this oil be found? Many billions of barrels of oil are yet to be discovered within the older basins which have been prolific producers for years. A basic concept to follow is to look for more oil where oil has been found. Prolific petroliferous basins were the sites for petroleum generation through many periods of geologic time. The sedimentary section of most basins has been explored by layers with the deeper beds only being investigated as the techniques for deeper drilling advanced. The high cost of deep drilling also has been a deterrent to investigating the deeper strata. Consequently, there still remains a thick sedimentary section inadequately tested. Such an example is the Wind River Basin in Wyoming.

Moreover, it does not follow that the older accumulations are always

Mr. Haas delivered this address as the keynote speech, 9th Annual American Association of Petroleum Geologists, Albuquerque, New Mexico, February 2, 1959.

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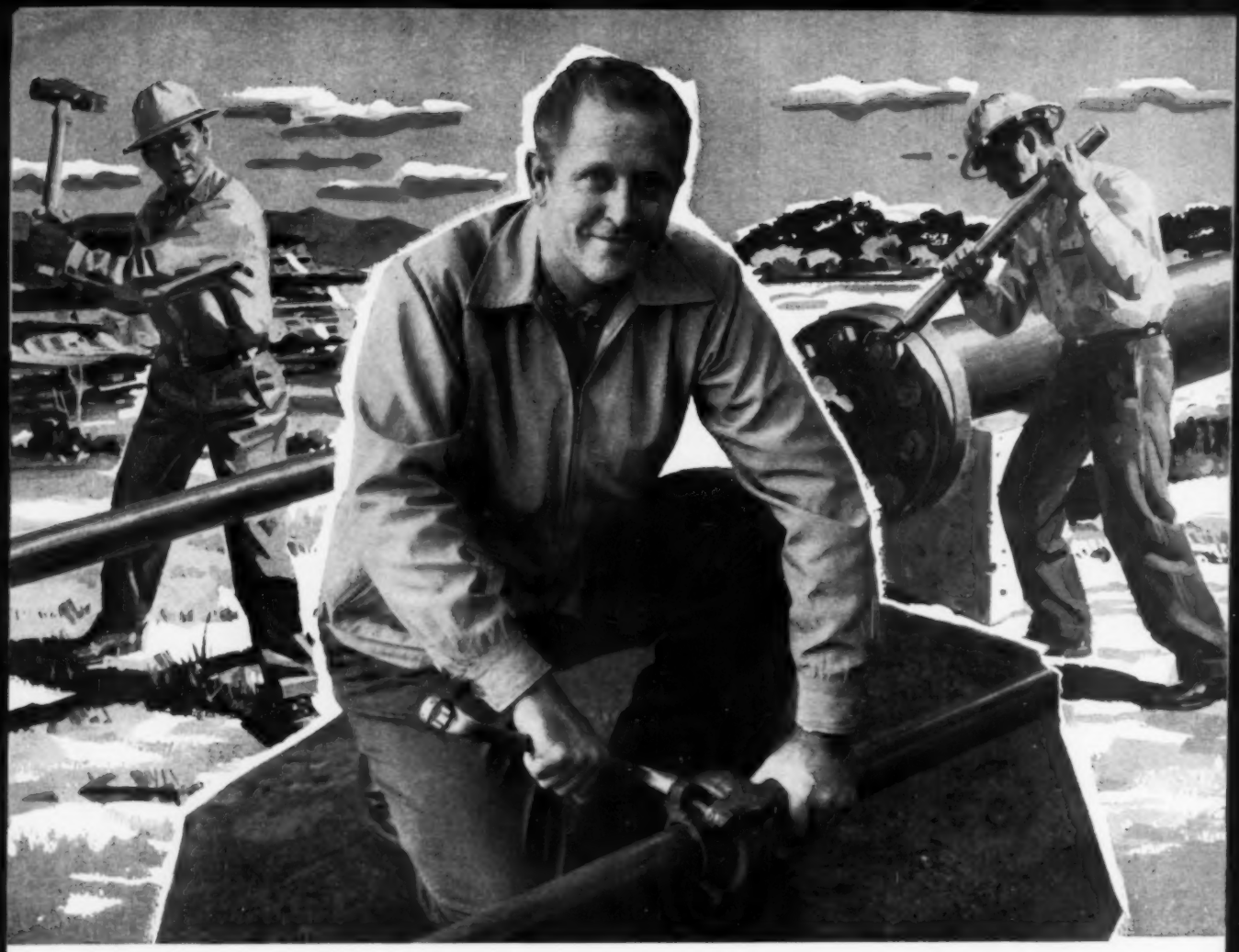

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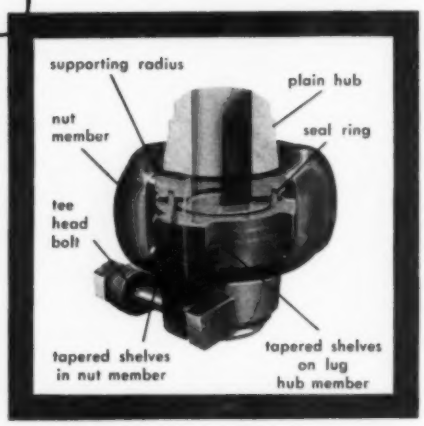
• One man, with a light-weight wrench, can make up or break out the largest size UNIBOLT Coupling (42″) in no time at all and with very little effort. The largest size Coupling requires only two bolts, and sizes up to 5″ are one-bolt design.

The UNIBOLT principle eliminates all threads between the component parts. Instead, tapered shelves on the nut and lug hub members travel against each other in a wedging action when the bolt is tightened. This leverage exerts tremendous pressure on the seats and seal ring.

The UNIBOLT Coupling is stronger than, say, flanged unions because its design places more metal in shear. Yet, it is lighter in weight than other couplings because it is so compact. UNIBOLT Couplings should last indefinitely because they require no destructive hammering for assembly or dismantling. And, their gaskets and seal rings are readily replaceable and obtainable from any supply store.

For any coupling job on threaded, butt weld, or socket weld pipe, or for any pressure vessel closure, UNIBOLT Couplings are your best buy.



The above drawing shows a UNIBOLT Coupling partially cut away and the nut member in a transparent blue color to reveal the mechanical features of the coupling.

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1-EE University in Pecos County, Texas, the world's deepest well (25,340 feet) recently established new records for casing and cementing. At the 22,919-foot level, a 7- and 7⅝-inch casing string was run to seal off nearly 12,000 feet of open hole extending below a 9⅝-inch string set to 10,996 feet. In cementing, the slurry reached from the casing shoe at 22,919 feet up to 4,100 feet—the longest single stage cement column ever placed . . . some 18,819 feet.

For this difficult job, the slurry weight was kept at 10.8 lbs./gallon with a low-density system of 40% Diacel D and 1.5% Diacel LWL (a low water loss and retarder additive) mixed with slow-set cement. Displacement pressure averaged about 1600 psi during most of the job. Logged bottom-hole temperature was 315°F. In all, mixing, pumping and displacing some 5,183 cubic feet of this low-density cement slurry required only 3 hours and 37 minutes . . . well within the calculated pumping life of 5 hours and 4 minutes.

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1-EE University, drilled to a record depth of 25,340 feet. Insert shows bottom joint of 7-inch casing going in.

*A trademark

DRILLING SPECIALTIES COMPANY
Bartlesville, Oklahoma

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coincident with the shallower ones. Oil occurs in commercial quantities only when the proper relationship exists between the source beds and the reservoir. Within a basin this relationship may vary for each geologic layer at widely separated areas. Yet many of the deeper tests have been confined to the areas of younger production. The Denver Basin is an excellent example of inadequate prospecting below the Cretaceous.

'Worn Out' Basins

The statement is often made that a particular basin is almost "worn out." To some extent, this is true. Each barrel produced leaves one less barrel to recover, and some of the older explored basins have yielded exceptionally large volumes of oil. A study of the history of these supposedly "worn out" basins does not support such a dim viewpoint.

Plotting the productive history of a basin reveals some interesting facts. A productive peak is reached, followed by a substantial decline. Several years later a new and even greater productive peak is attained, followed by another inevitable decline. This cycle may be repeated several times within a basin. During the long periods of decline in production, the skeptics believed that the basin was "worn out."

What causes these productive peaks? Various factors may be the cause, such as a new geologic concept about oil occurrence, or the invention of a new finding tool or improvement to an existing method. Certainly our geologic reasoning has not become static nor will inventions cease, so I look forward confidently to new productive peaks in the "worn out" basins. The discovery of Cottonwood field in the Big Horn Basin, a stratigraphic occurrence of oil in a classical province of structural accumulations, illustrates this thesis.

Areas of Opportunity

The partially drilled basins in the Rocky Mountain region offer attractive opportunities for the oil finder. Some of these are large in size and have thick sedimentary columns. The well density is low. In these areas, the subsurface control is so poor that the geologic maps fail to depict the focal point of hidden accumulations. When sufficient information becomes available to better delineate the prospective areas, substantial volumes of oil will be added to the reserve picture. The Williston Basin of North Dakota-Montana and the Paradox Basin in Utah and Colorado are recent examples which are now developing significant reserves.

The Great Basin of Western Utah and Nevada is a huge area offering unlimited petroleum possibilities. It contains source and reservoir rocks, numerous oil shows in wells, some oil seepages and a thick sedimentary section, all the necessary components of other productive oil and gas provinces. The basin has one small producing oil field and an abandoned gas field. The complex geology and expensive drilling have restrained the enthusiasm of the oil finder for this region. When considering the well density for such an enormous area, and the measure of success already achieved, it must motivate the explorationist to carefully rationalize its merits. Development of this basin will be slow and will continue far into the future, but I predict some profitable surprises for the dedicated oil finder.

The bulk of the future oil in this territory will occur in stratigraphic traps. This is not an unfounded statement. There is mounting evidence that stratigraphic accumulations already are forging to the front. These are, the discoveries along the Midale trend in Saskatchewan, Canada, and North Dakota; the Cottonwood, Barber Creek and Dead Horse Creek fields in Wyoming; the Adena field in Colorado; and the Aneth field in Utah.

"Unless costs are cut, cheaper produced crudes or some other form of energy will supplant domestic crude . . . It is later than you think!"

Finding the Traps

The explorationist must apply the fundamental components of petroleum geology to effectively find the stratigraphic traps. Our modern concepts of "Basin Architecture," recent advances in the studies of the "Origin and Migration of Petroleum," new techniques for identifying "Source Rocks," better methods of "Presenting Geophysical Data," improved "Subsurface Mapping Techniques," and "Hydrodynamics" have elevated the oil finding effort to a new plateau. This broader understanding of oil occurrence has resulted in significant changes in exploration thinking and philosophy in recent years. These new concepts certainly will aid the stratigraphic search if properly applied.

A thorough knowledge of the surface exposures is essential. The outcrops have been slighted within recent years. The geologist, seeking sedimentary changes within a formation in the subsurface, should have detailed information about its occurrence on the surface. Do the surface exposures permit the conclusions derived from the subsurface data, or do they suggest other determinations? The Rocky Mountain region provides a real opportunity for these studies which are so necessary in stratigraphic work. Have you, as an oil finder, taken advantage of this opportunity recently and examined the outcrops in light of the ever increasing subsurface data? This is a periodic must because relying on old impressions of the section leads one far astray.

Sample examination of the sediments has been likewise neglected during recent years. Too much reliance has been placed on the electric log in mapping the sediments in the subsurface. Unfortunately, subtle indicators of sedimentary changes are not apparent on the electric logs and these provide clues to possible stratigraphic entrapments. The quality of sample examination must be improved. Gross lithologic descriptions no longer supply the information that is necessary to locate sedimentary traps. Detailed sample studies are therefore imperative. The industry needs to enlist the aid of our educational institutions to stress this phase of training for future explorationists.

To effectively locate stratigraphic accumulations requires a drastic improvement of rock classifications. Consideration must be given to the environmental conditions under which the rocks were laid down. The pattern of detailed rock types will reveal where the proper relationship exists between source and reservoir. To establish a workable classification which can be universally adopted by industry is a real challenge. Such a project offers a fertile field for research.

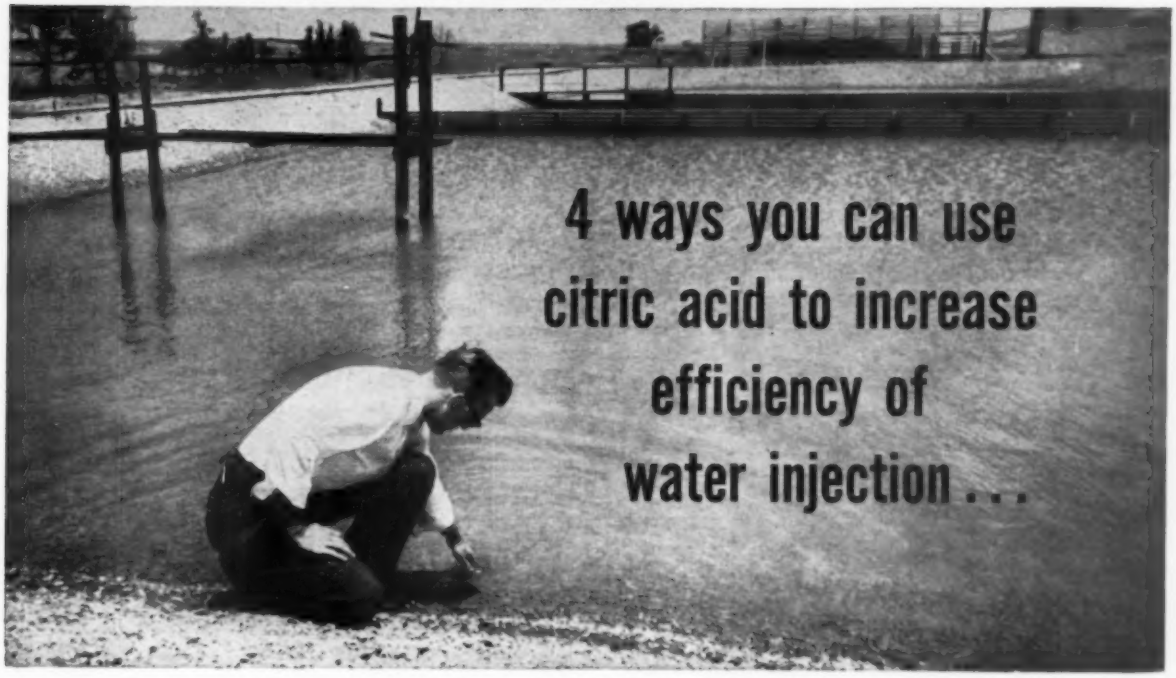
New Techniques

In exploration research, the greatest strides since World War II have been in improving seismic techniques and interpretation. Some of these are continuous velocity logging, synthetic seismograms, magnetic recording, data processing and presentation. These improvements have also sharpened the seismograph as a finding tool and the pinpointing of stratigraphic traps is now within the realm of possibility. However, the method is expensive and must be properly applied through the integrated and team effort of the geologist and geophysicist.

The study of hydrodynamics or fluid pressures is a new approach in petroleum exploration. It is an aid in explaining the reservoiring of oil and will have broad application in the search for stratigraphic oil.

Progressive explorationists will adopt and exploit fully these concepts and techniques. But, their efforts will

Iron is probably the most serious cause of plugging problems at three out of five water flood projects . . .



The success of citric acid in increasing water injection efficiency has been proved in four distinct types of applications. Variations in water quality and operating conditions will determine which application you should use. **In each case, citric acid sequesters iron in your injection water, prevents the serious plugging action of iron precipitates.**

1. Maintenance Treatment entails the constant addition of citric acid (3:1 or 4:1 ratios of citric to iron content) to prevent iron from filtering out on the sand into which the water is injected. This, of course, helps to maintain high injection rates at normal pressures. For best results in maintenance treatment with citric acid, a water injection plant should be operating at optimum injection rates and pressures.

Two salt water disposal wells in southern Texas, with average injection rates of 200 to 400 barrels per day showed a 30 percent increase in injection shortly after only 8 ppm addition of citric acid was started as maintenance treatment.

2 & 3. Acidizing and Detergent Treatments are very important adjuncts to successful maintenance treatment. When iron plugging the sandface has already caused lowered rates and/or high pressures, acidizing with citric and hydrochloric acids or cleaning with detergents plus citric acid are excellent methods for returning the injection wells to optimum conditions.

A well in Oklahoma showed marked improvement after acidizing with a solution of 260 pounds citric acid, 25 gallons Triton* X-100, 250 gallons 15% hydrochloric acid and 500 gallons water. The injectivity index rose to 195 bbl./day/ft. of pay from 3 bbl./day/ft. of pay. Gradual decline was noted over a short period, but the index leveled at 80 bbl./day/ft. of pay.

4. Slug Treatment with citric acid is designed for those systems where the water contains iron which cannot be economically treated to keep the iron in solution, or for those systems where the iron is completely precipitated before the water can be treated. Slug treatment at 500 ppm once every 4 to 6 weeks sufficiently lowers the pH to dissolve much of the insoluble iron, and the cost of treatment is low when averaged over this period of time.

A well in southern Louisiana was treated by slugging with two 400-pound batches of citric acid, two weeks apart. Injection rates have more than doubled, from 4,000 to 8,640 barrels per day, at last report, and in addition, the pressure has averaged 300 psi lower than previous requirements.

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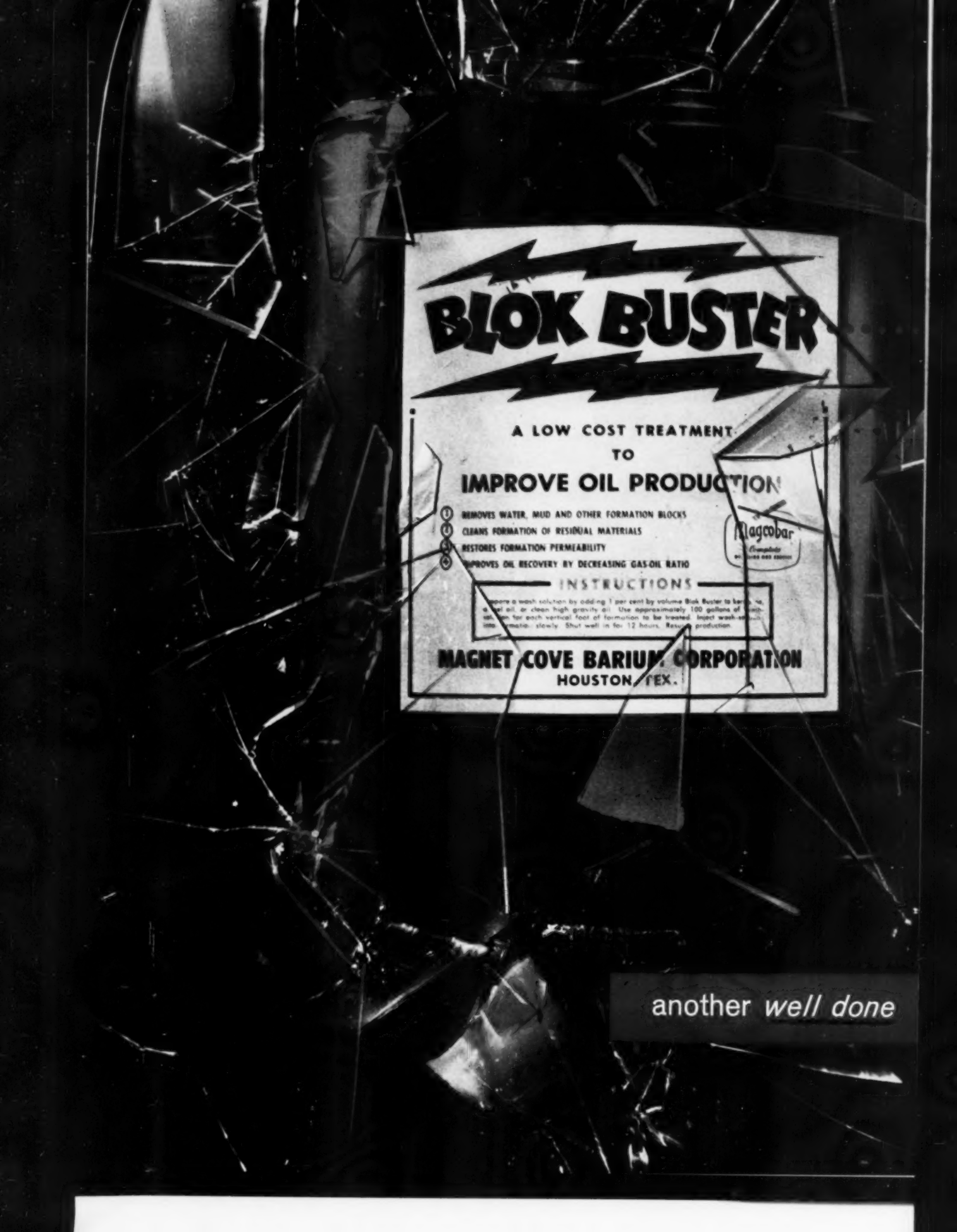
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Blok Buster increased production in these wells

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Well did not resume normal production after workover

Well producing 1 MMCF gas and 30 to 35 bbl. distillate per day from Frio was killed. Following workover, the distillate production was lost. After a 5-gal. Blok Buster treatment, production was increased to 1.5 MMCF and 11 to 14 bbl. distillate per day. Two months later this production is still holding.

Well did not increase following hydraulic fracturing

Well had average production of 5 BOPD and 20 bbl. water. Following fracturing operation, well produced exactly same. Using 35 gal. Blok Buster, production after 21 days was increased to 16 bbl. oil and 11 bbl. water per day.

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Blok Buster is another example of the cost cutting products developed by Magcobar, proof that the right products *used right* on your wells can cut your costs. A Magcobar engineer can advise you on application techniques for your particular production problem. Blok Buster is available in 5-gallon cans from any of Magcobar's 500 stockpoints in the United States and Canada. Elsewhere, write Foreign Operations, P. O. Box 6504, Houston, Texas.

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not save exploration unless one basic fact is clearly recognized. High cost crude can and will be priced out of the market by crudes produced at a lower cost.

As geologists, what have we done to face up to the situation and make our crude competitive? The only way to keep exploration alive is to find more oil with less dollars.

Something to Sell

Explorationists have a commodity to sell — the art of finding oil — but it must be found more economically. Unless costs are cut, cheaper produced crudes or some other form of energy will supplant domestic crude. Someone else will do the job of supplying our percentage of the energy requirements. The number of geologists will dwindle and those who survive the "exploration depression" will be employed in foreign lands. It is later than you think!

Some will be quick to point out that today's stratigraphic oil is more difficult and expensive to discover than structural oil. I agree it is more expensive. However, stratigraphic accumulations are more difficult to locate now than were most of the subsurface structural ones processed by pioneer geologists before modern exploration methods developed. Oil always has been hard to find. The written accounts of our predecessors on this subject amply testify to the elusiveness of oil.

Drilling depths also will increase year after year. As a result, more people and more and deeper holes add up to greater expense per barrel discovered.

False Charges

Unfortunately, and in many instances, for one reason or another, the oil industry has been unable to pass along to the consumer these increased costs. In the past when the price of gasoline or other petroleum products has been advanced because of increased costs, there have been public officeholders and political writers, picturing themselves as protectors of the consumer, who have raised a hue and cry. Congressional committees have conducted investigations, ostensibly for the purpose of uncovering the sinister implications of this very natural sequence of events. The industry has been forced to answer false charges, and such charges have not subsided even when it was shown by figures like those of the United States Bureau of Labor Statistics for November 1958, that the consumers price index for all commodities is 123.7, as compared with an average index for 1958 for gasoline of 113.0 ex taxes.

Positive Action!

You can keep the crude you discover competitive by taking positive action along the following lines.

1. Leave your maps and microscopes long enough to do some leg work for the enactment of strong state conservation statutes relative to the development and operation of petroleum reservoirs.
2. Use only the exploration methods most feasible and economical for the area under consideration. Explorationists have been guilty of an expensive habit which is the tendency to use costly methods in areas where they are not applicable.
3. Reduce costs by producing more crude with fewer wells. This means wider spacing. Today's operations are proceeding, in many instances, under spacing concepts developed nearly a generation ago. Meanwhile, reservoir engineering has made giant strides toward understanding reservoir performance. This knowledge results in the conclusion that substantially fewer wells are needed in most producing reservoirs to efficiently deplete the recoverable reserves. Geologists must strongly urge wider spacing which will be economically sound. Producing at a higher rate with a reduced investment in fewer wells, oil production can approach the competitive position of foreign imports.
4. Develop and operate a field as one unit. This means merging all interests. I am sure you are aware of the advantages of unitization and its resultant economics. These are: (1) Development of a field with reduced investment by drilling fewer wells and eliminating duplication of service facilities by each operator; (2) It increases ultimate recovery through applying the optimum producing rate per well and facilitates secondary recovery projects.
5. The cost of drilling and completing wells must be reduced. The search must continue for better drilling methods. Slim holes, changes in casing practices, and improved cementing procedures are some of the factors to be investigated. In addition, there is an urgent need for more precise methods of formation evaluation in order to eliminate unnecessary and expensive testing procedures.
6. Finally, aggressive action is needed to tell others — business, civic, educational and governmental leaders—about industry's problems. Let us quit talking to ourselves. Others, when enlightened with the facts and realizing the consequences to each United States citizen, will join the crusade.

"Aggressive action is needed to tell others — business, civic, educational and governmental leaders — about industry's problems. Let us quit talking to ourselves."

Inform the Critics

It is your fight when uniformed critics advocate the weakening of the percentage depletion provision from the tax laws. Without the percentage depletion "incentive exploration" will join the Dodo bird in the museum case. Percentage depletion was enacted specifically to stimulate and maintain the discovery of crude supplies. It has functioned well in achieving the desired result. In view of the tremendous demands forecast for the future, the need for the stimulus of the percentage depletion provision is more vital now than ever before.

Resist Socialists

One final warning, resist to the utmost the creeping Socialism and strangling governmental controls being used to shackle the oil industry. You, as explorationists, have always been free. Because of this you found oil. When that freedom vanishes, and there is evidence that this is happening, your power to earn a living is gone too. More important, the United States will be relegated to the position of a second rate power, and a lowering of your standard of living will inevitably follow. It is a challenge to the United States to maintain its leadership. If we cannot, as the most highly industrialized nation in the world, meet this challenge with the "know how" and technical excellence which we possess, then indeed, we will have no right to complain about our lot.

These are the problems of the explorationist today.

If we will stand up, fight and work together, we can solve them with wise aggressive action just as many other difficult problems in searching for oil have been solved in the past. Exploration can be saved if we take positive action now.

1. Davis, Morgan J., "Let's Stop Selling U.S. Reserve Short," *Oil & Gas Journal*, December 8, 1958.
2. Megill, R. E., "The Cost of Finding Oil," 1959. Unpublished.

★ ★ ★

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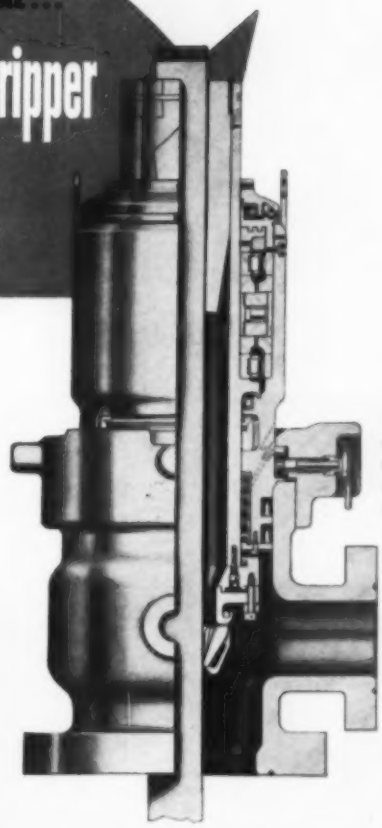
The Shaffer Rotating Blowout Preventer and Stripper IS UNEQUALLED!



WHENEVER you're drilling in unknown formations—or in troublesome zones where pressures are a problem—make sure you install the unequalled protection you get with the Shaffer Rotating Blowout Preventer and Stripper.

HERE'S a unit that maintains *continuous* pressure control as long as the drill string is in the hole—whether the string is rotating, is being raised or lowered, or remains stationary. Since pressure control is continuous, emergencies can't happen too fast for this unit, because it is *always* sealed off around the drill string until the string is removed from the well. Note the many unusual features as outlined below...

***PRESSURE SEAL IS CONTINUOUS*— not only while running the varying shapes of the drill string in and out of the hole, but also during rotation and while pipe is stationary. Moreover, the sealing unit automatically adjusts itself to maintain its seal. No manual operations are necessary!**

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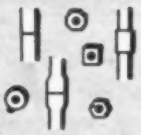
Note space-saving compactness. Even flow-line connections are built-in, eliminating need for spools.



SEALS VARYING DIAMETERS AND SHAPES because the Stripper Rubber *automatically* expands and contracts to maintain a pressure-tight seal around the elements in the drill string—the varying diameters of flush, upset and coupled pipe, drill collars, subs, etc. . . . and any shape kelly, whether square, hexagon or octagon!

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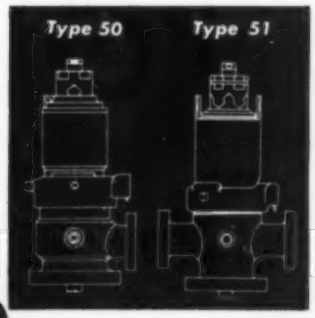

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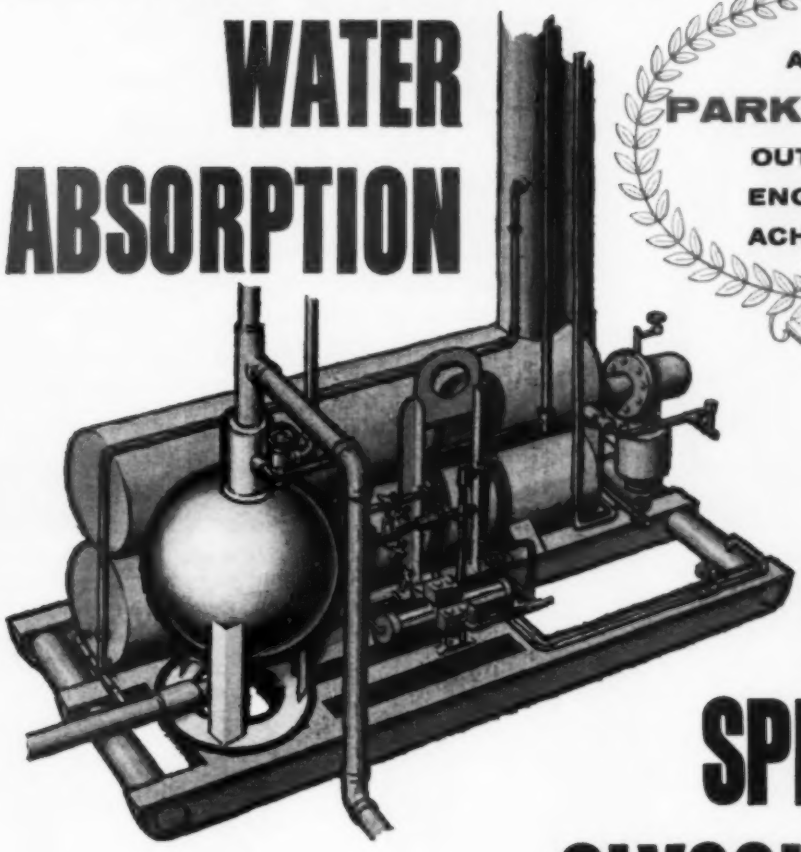

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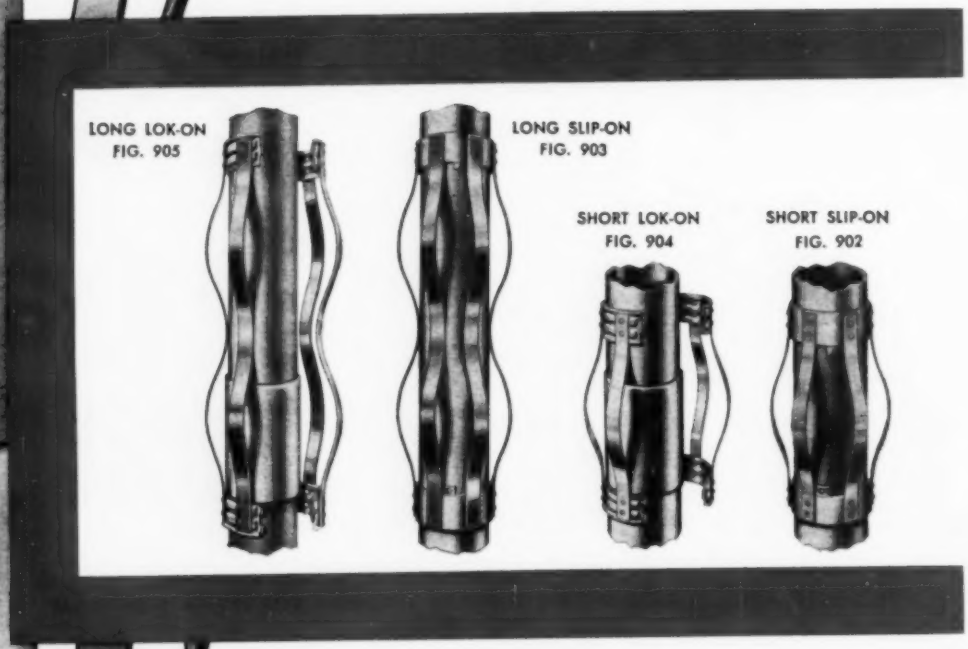

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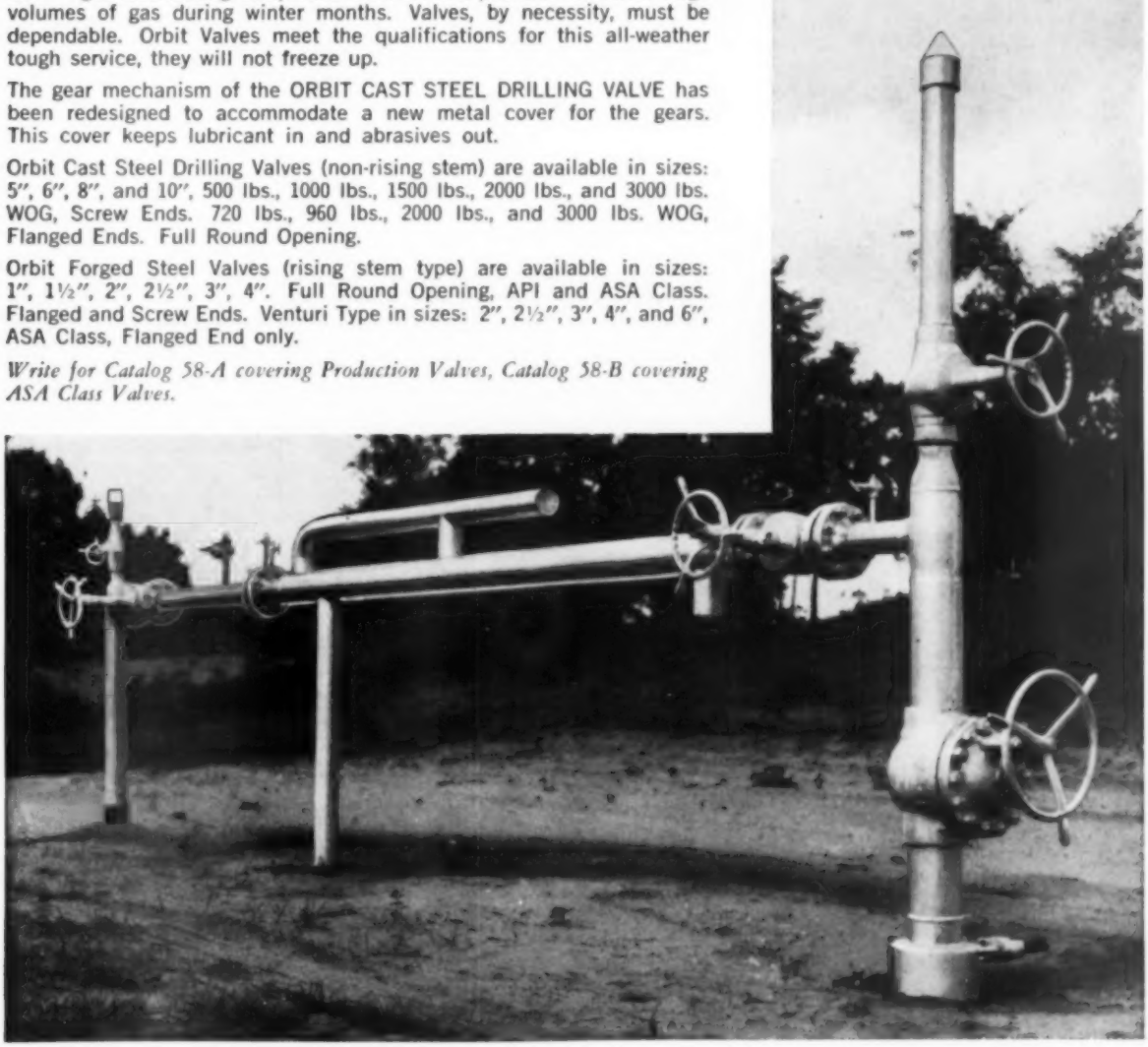

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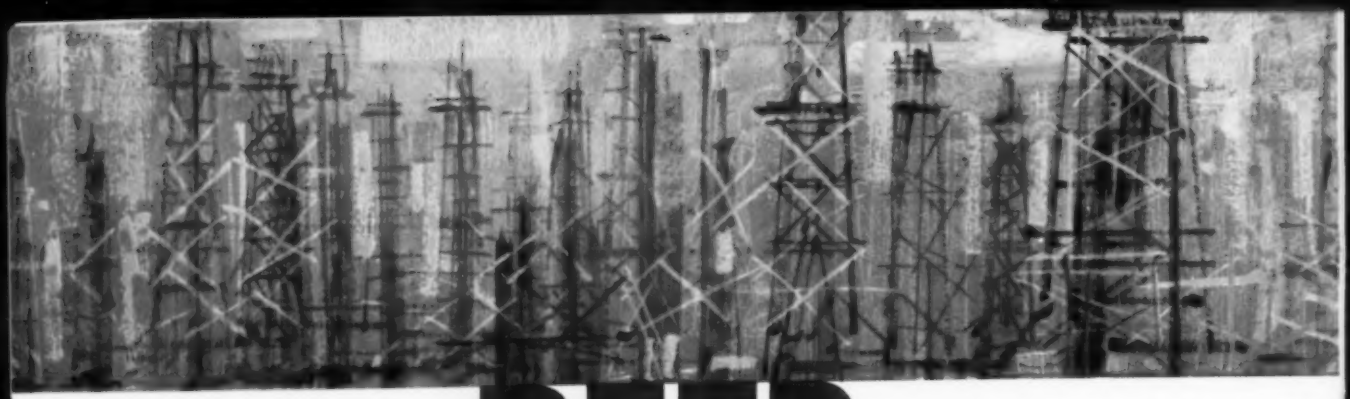

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1936 ... Reed pioneered the Internal Flush tool joint which was to become API standard

1935 ... Reed engineered and designed the tool joint which substantially eliminated last engaged thread failures—the Shrink-Grip tool joint

1934 ... The first cross cutter rock bit with ball thrust bearings

1930 ... The first unitized rock bit

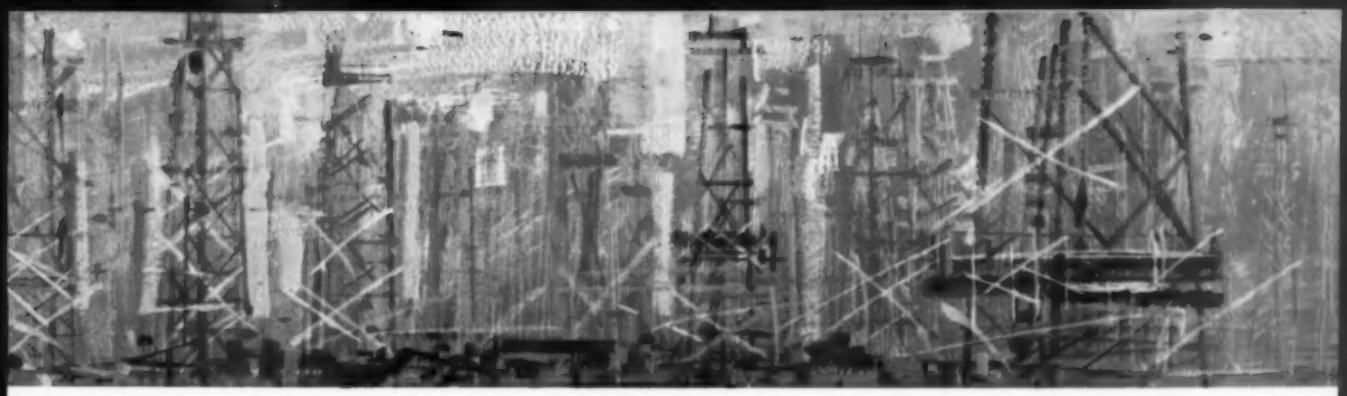
1930 ... The first bridge-type rock bit having replaceable watercourses to provide jet action on cutters and on bottom of hole

1929 ... The first rock bit with slush lubricated roller bearings

1928 ... The first bridge-type rock bit

1927 ... First field use of hard metal applied to cutter gage faces

1926 ... Reed introduced a rock bit with longer teeth and improved slush lubricated rolling cutters, greatly increasing footage per bit



industry on it's 100th anniversary

And Reed Is Proud To Have Been A Part Of This Industry For 42 Years.

For 42 years Reed has been a part of the petroleum industry and through continuing research and service has contributed to the growth of this industry by designing and selling tools that help to produce more oil, more economically. The items listed are representative of Reed's contributions through the last 42 years.

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1925... The first rock bit with slush lubricated rolling cutters

1926... Reed pioneered the Full Hole tool joint which was to become API standard

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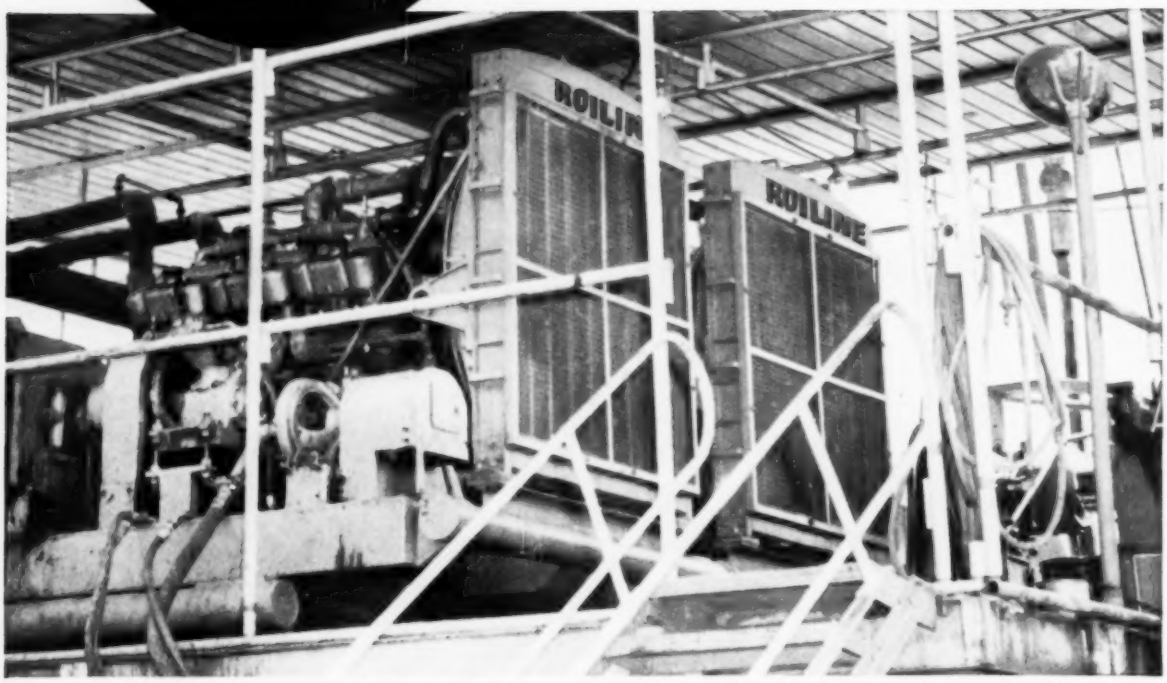

Langford Drilling Co. Rig No. 2 drilling well at Sherman, Texas, for Lone Star Gas Co.—powered by two L-3000 Roiline gas engines—3006 cu. in. displ., V-12 cylinders, 6¾-in. bore x 7-in. stroke—each 402 max. hp at 1100 rpm.

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KANSAS, Garden City, Carson Machine & Supply Co.
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OKLAHOMA, Chickasha, Chickasha Gin & Mill Supplies
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TEXAS, Houston 1, Southern Engine & Pump Co.
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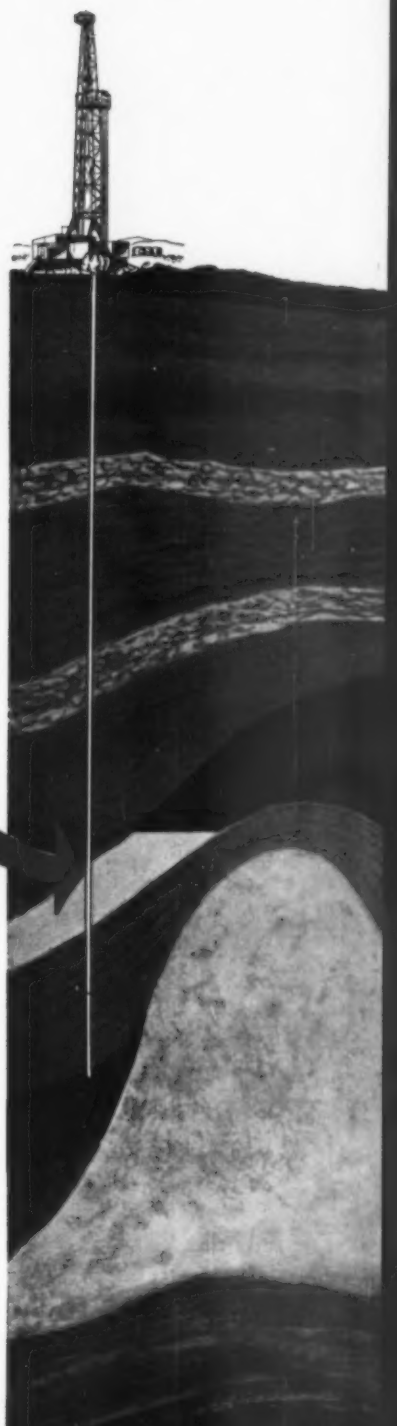

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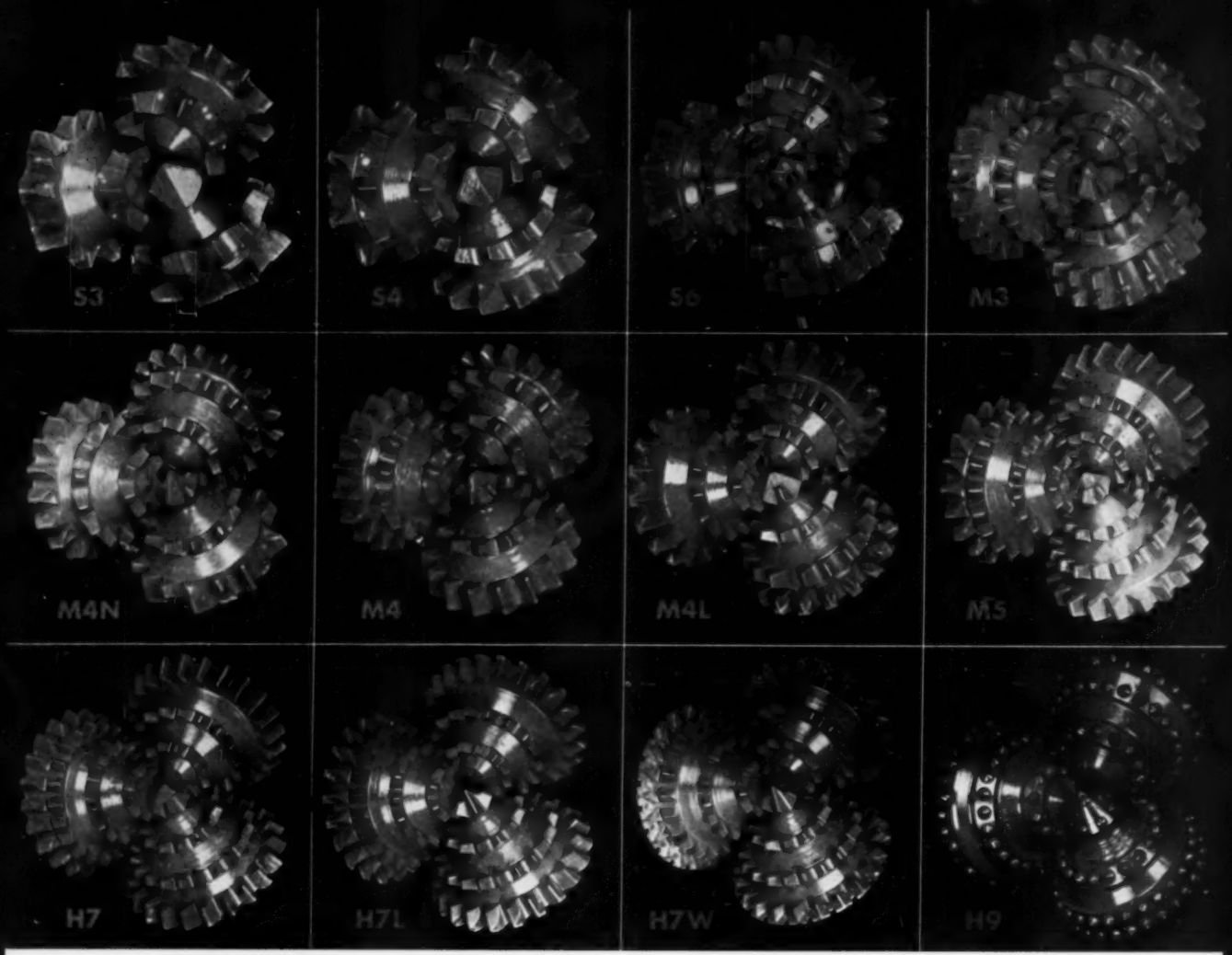

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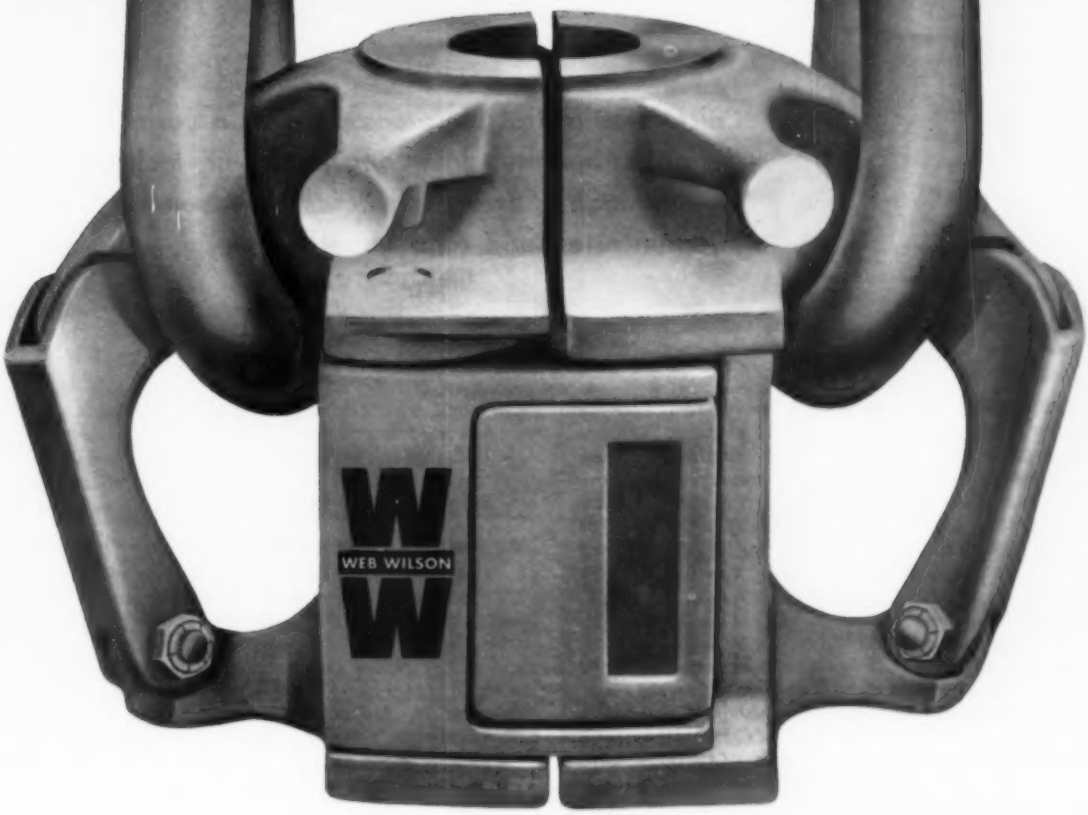

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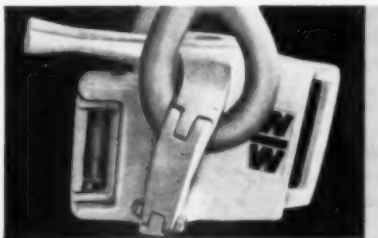
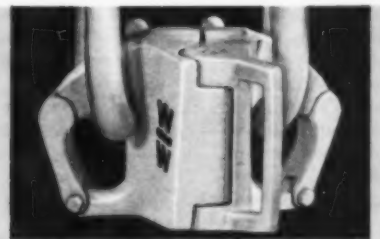


SWEPT FORWARD LINK ARMS allow greater clearance for installing links, and more freedom for the elevator to roll and turn while hanging in links.



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Efficiency and Economy Will Result From . . .

Engineered Hydraulic Fracture Treatments

Part 1

Calculation of fracture areas provides a yardstick for designing optimum fracturing programs, including consideration of fracturing fluids, fluid volumes, injection rates, and sand quantities

Davis D. Hunt and Horace R. Crawford
The Western Company, Midland, Texas

HYDRAULIC FRACTURING has proved to be one of the biggest bargains in the producing end of the oil business. However, the present squeeze on profit margins is causing oil producers to sharpen their pencils and try to get more out of their operating money wherever it is spent. To this extent, operators appear to be manifesting a great deal of interest in systematic approaches to the design of these operations. Systems have been designed for predicting treatment pressures and rates, and for determining the proper use of blocking techniques such as ball sealers. In addition, there now appears to be a demand for a system for designing optimum fracturing fluids, fluid volumes, injection rates and sand quantities.

This report presents a simplified field-adapted method for designing fracturing operations. Basically, the technique is one presented to the industry in a paper by G. C. Howard and C. R. Fast at the 1957 Spring Midcontinent API Meeting and entitled "Optimum Fluid Characteristics for Fracture Extension." The technique involves only rigorous mathematical derivations from easily justified assumptions. From this standpoint, then, it is physically correct. From the practical point of view, of course, no formula is any more correct than the data fed into it. It will become apparent, however, that the method provides a powerful tool for treatment evaluation, with data normally available in the field.

A very general statement may be made about fracturing treatments — the more frac fluid used, the lower the fluid loss of the fluid, the more sand used, and the higher the injection rate, the better will be the results. But such a statement overlooks many physical and economic factors. Also, it does not say how much additional good such unlimited increases will produce. Designing treatments from such an attitude would almost always produce prohibitively expensive proposals. Instead, jobs shoud be designed to produce *optimum* results in the light of physical and economic factors.

CALCULATING FRACTURE AREAS

In order to design the optimum job there must be a yardstick. The most reliable measure of a fracture treatment is the radial extent of fracture created, or in other terms, the area of the fracture. The task, then, is to develop a reliable method for estimating this extent. It is then possible to examine individually the various factors which affect the calculated extent of fracture or fracture area.

Approach to the Problem

A qualitative consideration of the events which take place during a fracture treatment is of value here. A fracture has just been initiated and more fluid is being pumped into it from the surface by way of the tubing or casing. The fluid can go two places. One, since the walls of the fracture are permeable rock, fluid can flow out through the walls into the reservoir. As far as fracture extension is concerned, this fluid is lost. Or, two, it can stay in the fracture, thus increasing the fracture volume. Assuming a constant fracture width, this increase in volume increases the fracture extent or area.

The question is then how much fluid actually does leak out of the fracture and how much stays in it. A calculation of how many gallons of fluid are in the fracture at any time is a measure of its size.

Simple analysis of the mechanism just described will reveal the general variables affecting fracture area. Injection rate and its related variable, pumping time, are two — they determine the time during which leak-off can occur. Another is fracture clearance or width, the divisor relating volume to area. A fourth is the volume of treatment which, mathematically speaking, has already been expressed by setting an injection rate and a time. The final general variable is the leak-off rate.

This last factor is most easily handled by use of a *fracturing fluid coefficient, C*. This coefficient incorporates the several variables which control the leak-off rate. The definition of C will be developed more rigorously later. For the time being C is a measure of the leak-off rate.

The Fracture Area Equation

When a fracture treatment is started the surface area of the fracture is quite small and the total leak-off of fluid from the fracture is correspondingly small. As the treatment

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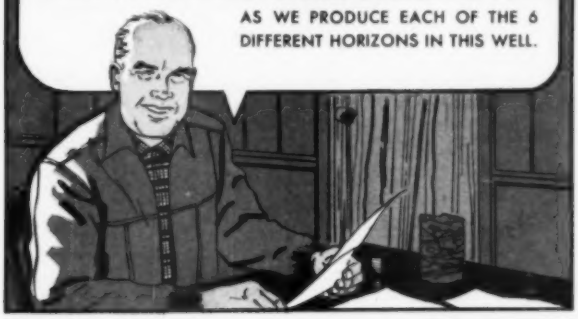
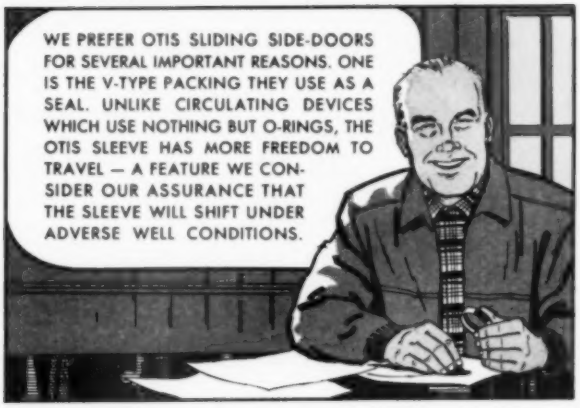
WILL SAVE US SEVERAL HUNDRED DOLLARS PER ZONE

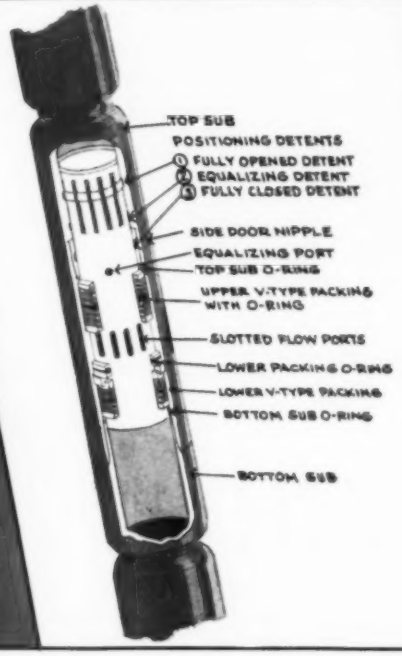
AS WE PRODUCE EACH OF THE 6 DIFFERENT HORIZONS IN THIS WELL.



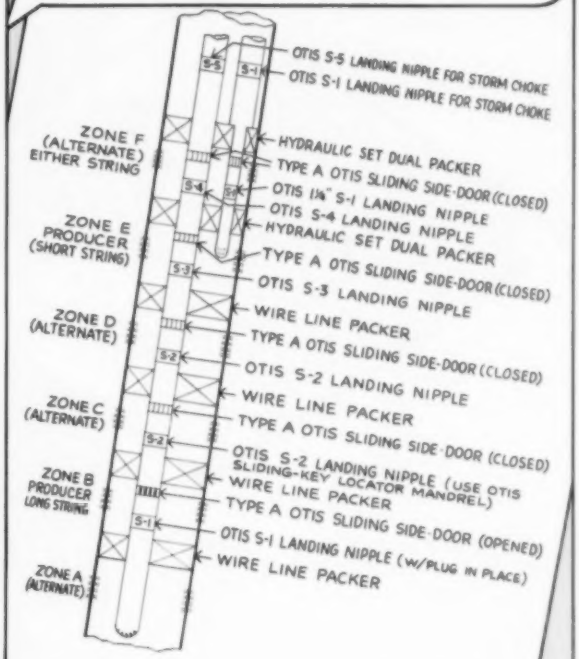
WE PREFER OTIS SLIDING SIDE-DOORS FOR SEVERAL IMPORTANT REASONS. ONE IS THE V-TYPE PACKING THEY USE AS A SEAL. UNLIKE CIRCULATING DEVICES WHICH USE NOTHING BUT O-RINGS, THE OTIS SLEEVE HAS MORE FREEDOM TO TRAVEL — A FEATURE WE CONSIDER OUR ASSURANCE THAT THE SLEEVE WILL SHIFT UNDER ADVERSE WELL CONDITIONS.



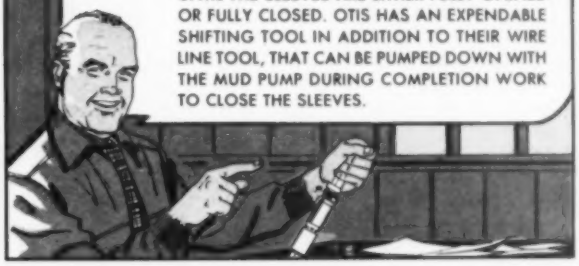
THEN THERE'S OTIS' VERTICAL SLOTTED PORT DESIGN. THIS GIVES OTIS SLIDING SIDE-DOORS MAXIMUM STRENGTH—AND ACTS TO PREVENT DISTORTION OF THE TOOLS AS THEY ARE SUBJECTED TO THE STRESS AND TORQUE OF A PRODUCTION STRING. HERE'S A DETAILED DRAWING OF THE TYPE A OTIS SLIDING SIDE-DOOR. NOTICE THE DESIGN ADVANTAGES.



ADD TO THAT THE THOUSANDS OF DOLLARS WE SAVED BY DRILLING ONLY ONE WELL TO PRODUCE THESE 6 FORMATIONS AND YOU'LL SEE WHY WE'RE SOLD ON MULTIPLE-ZONE WELLS AND OTIS SLIDING SIDE-DOOR EQUIPMENT. HERE'S A DIAGRAM OF THE WELL.

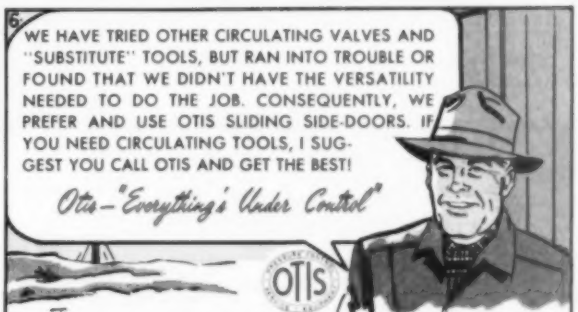

OTIS S-5 LANDING NIPPLE FOR STORM CHOKE
OTIS S-1 LANDING NIPPLE FOR STORM CHOKE
ZONE F (ALTERNATE) EITHER STRING
HYDRAULIC SET DUAL PACKER
TYPE A OTIS SLIDING SIDE-DOOR (CLOSED)
OTIS 1¼" S-1 LANDING NIPPLE
OTIS S-4 LANDING NIPPLE
ZONE E PRODUCER (SHORT STRING)
HYDRAULIC SET DUAL PACKER
TYPE A OTIS SLIDING SIDE-DOOR (CLOSED)
OTIS S-3 LANDING NIPPLE
ZONE D (ALTERNATE)
WIRE LINE PACKER
TYPE A OTIS SLIDING SIDE-DOOR (CLOSED)
OTIS S-2 LANDING NIPPLE
ZONE C (ALTERNATE)
WIRE LINE PACKER
TYPE A OTIS SLIDING SIDE-DOOR (CLOSED)
OTIS S-2 LANDING NIPPLE (USE OTIS SLIDING-KEY LOCATOR MANDREL)
ZONE B PRODUCER LONG STRING
WIRE LINE PACKER
TYPE A OTIS SLIDING SIDE-DOOR (OPENED)
OTIS S-1 LANDING NIPPLE (W/PLUG IN PLACE)
ZONE A (ALTERNATE)
WIRE LINE PACKER

ANOTHER ADVANTAGE OF THIS OTIS EQUIPMENT IS THAT WITH THEIR SHIFTING TOOL THEY CAN OPEN AND/OR CLOSE ONE OR SEVERAL SLEEVES WITH JUST ONE TRIP OF THE WIRE LINE. AND YOU'RE SURE THE SLEEVES ARE FULLY SHIFTED, TOO. OTIS' SHIFTING TOOLS WON'T RELEASE UNTIL THE SLEEVES ARE EITHER FULLY OPENED OR FULLY CLOSED. OTIS HAS AN EXPENDABLE SHIFTING TOOL IN ADDITION TO THEIR WIRE LINE TOOL, THAT CAN BE PUMPED DOWN WITH THE MUD PUMP DURING COMPLETION WORK TO CLOSE THE SLEEVES.



WE HAVE TRIED OTHER CIRCULATING VALVES AND "SUBSTITUTE" TOOLS, BUT RAN INTO TROUBLE OR FOUND THAT WE DIDN'T HAVE THE VERSATILITY NEEDED TO DO THE JOB. CONSEQUENTLY, WE PREFER AND USE OTIS SLIDING SIDE-DOORS. IF YOU NEED CIRCULATING TOOLS, I SUGGEST YOU CALL OTIS AND GET THE BEST!

Otis—"Everything's Under Control"



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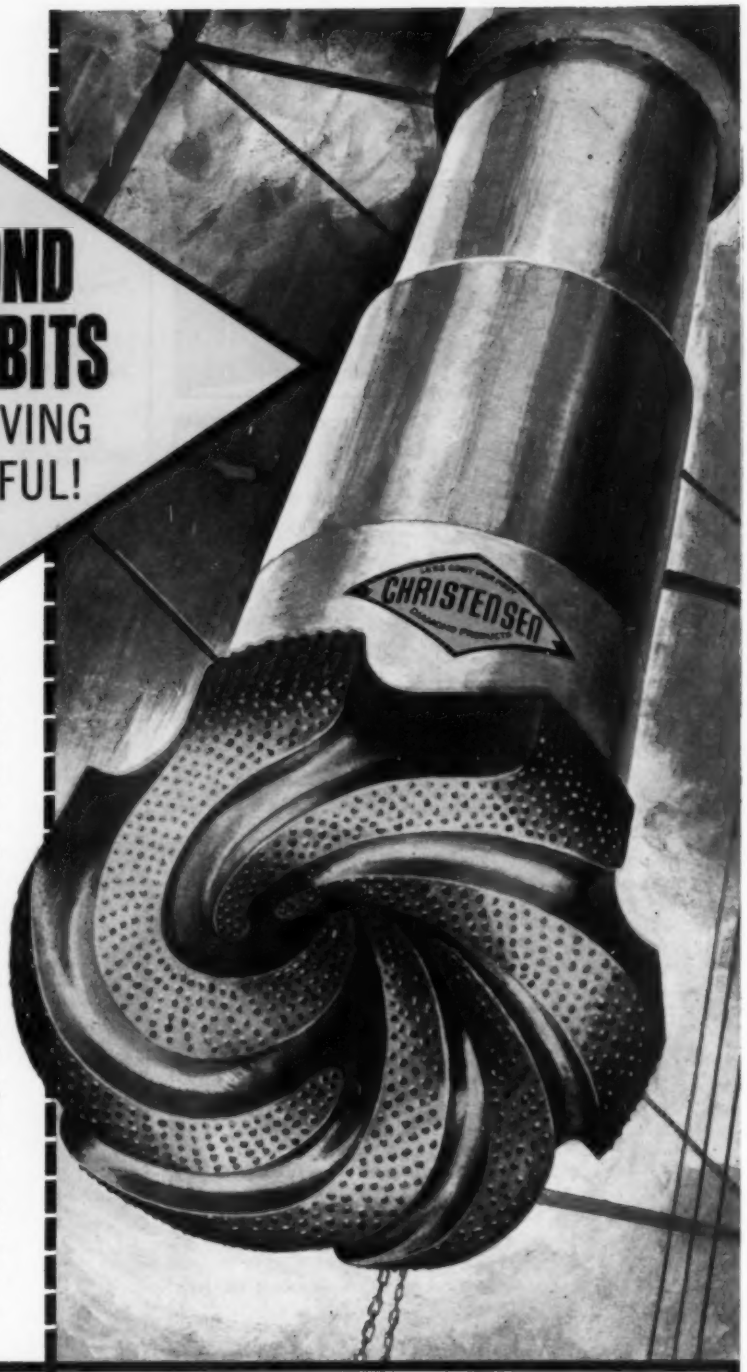

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Diamonds Mean, "Less cost per foot."

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progresses, there is created an ever-increasing surface area available for leak-off of fluid. This fact does not make it impossible to determine accurately the area at any time, but it does make the resulting equations somewhat complex. The equation for estimating the area of fracture created by a treatment, based on the derivation by R. D. Carter, is as follows:

$$A = \frac{QW}{4\pi C^2}\left[e^{x^2} \cdot \operatorname{erfc}(x) + \frac{2x}{\sqrt{\pi}} - 1 \right],$$

where:

$$x = \frac{2C\sqrt{\pi t}}{W}.$$

A = total area of one face of the fracture, sq ft.

Q = constant injection rate during treatment, cu ft per min, or bbl per min times 5.614.

t = total pumping time, min.

W = constant fracture width or clearance, ft.

C = a constant which is a measure of flow resistance of the fluid leaking off into the formation during fracturing treatment.

erfc(x) = complement error function of x.

Thus, with a knowledge of these factors, the fracture area created by any treatment can be calculated as accurately as the knowledge of the data. Pumping rate and time are easily determined; it will in general be necessary to make an assumption of fracture clearance. The effect of this assumption will be considered later. The only question remaining, then, is the value of the constant C, the fracturing fluid coefficient.

The Coefficient C

It was stated before that C provided a measure of the leak-off rate. In the area equation, C is the only factor which reflects the differences in various formations and the differences in various fluids. Analysis of the properties of porous reservoirs and of the various types of fluids used shows that there are three types of flow mechanisms defined by C. In other words, C is really a combination of three types of effects.

One of these mechanisms primarily involves viscosity of the fracturing fluid. The second is concerned basically with the saturation of the reservoir with fluids of limited compressibility. The third deals with the effects of fluid loss additives. These mechanisms, as they are developed below, will be represented by C_I, C_{II} and C_{III}, respectively. Each of these will be considered separately.

Viscosity of Fracturing Fluids

If the fracturing fluid to be used is of appreciably higher viscosity than the fluid in the reservoir, an equation can be written for a fluid loss coefficient. This coefficient shall be represented by C_I, as:

$$C_I = 0.0469\sqrt{\frac{k\,\phi\,\Delta P}{\mu}},\ \text{ft}/\sqrt{\text{min}}$$

where k is the permeability of the formation, ϕ is its porosity, ΔP is the difference in pressure between fluid in the fracture and fluid in the formation, and μ is the viscosity of the fracturing fluid.

This equation simply states that if the frac fluid is viscous it will not leak off infinitely fast. Instead, its rate of leak-off will be a number which can be calculated. The value of this number will depend on the particular permeability, porosity,

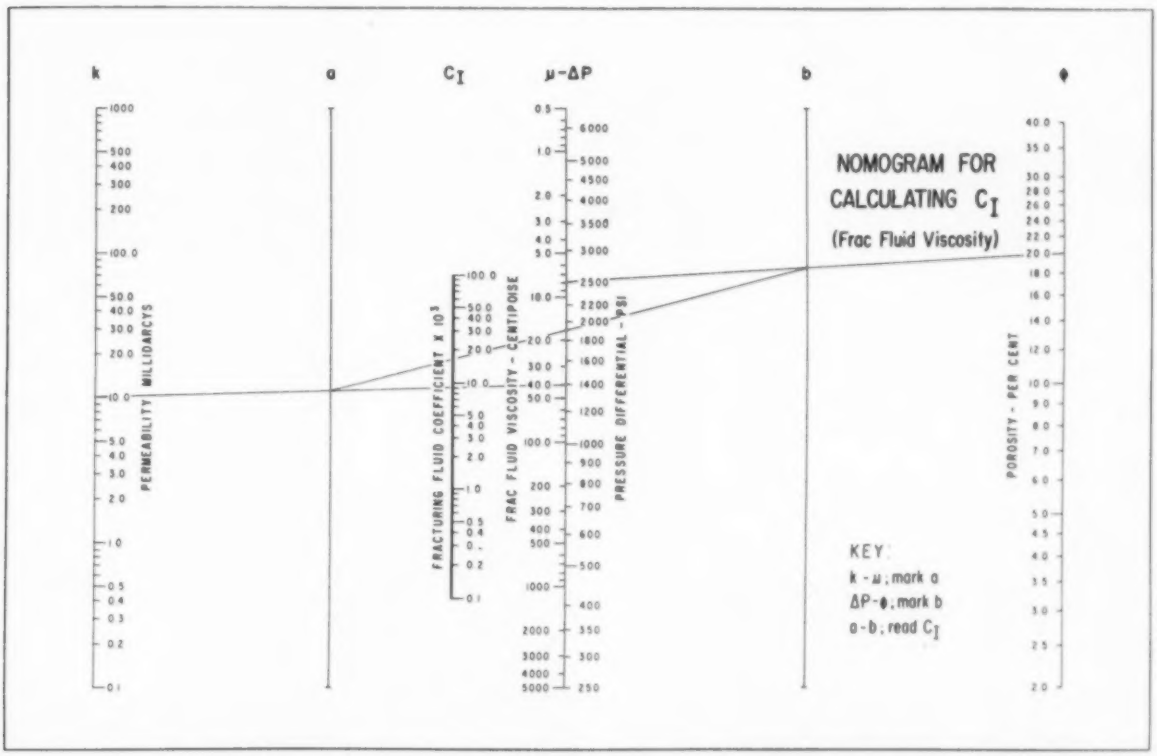

FIG. 1. **Nomogram for determination of C_I** gives a measure of the effects of fracturing fluid viscosity, coupled with permeability, porosity, and treating pressure differential. A sample calculation is included on the chart.

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Efficiency, economy for any type of completion

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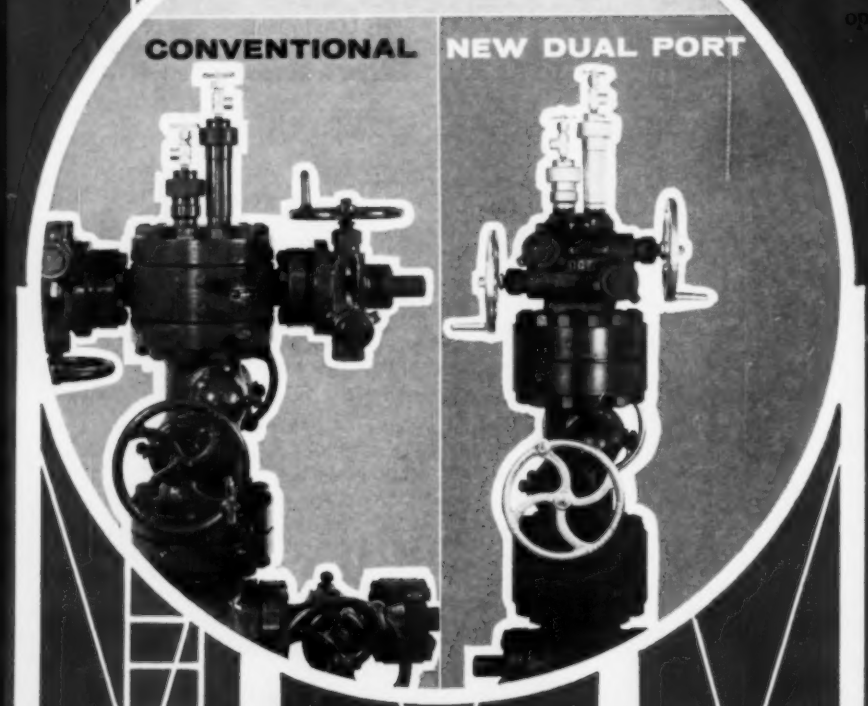
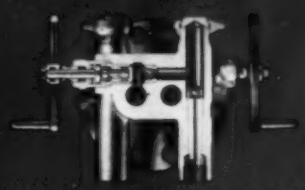
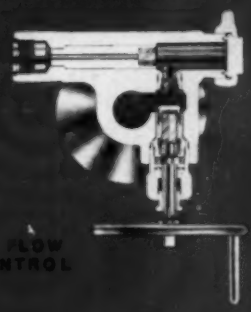


DUAL PORT FLOW CONTROL





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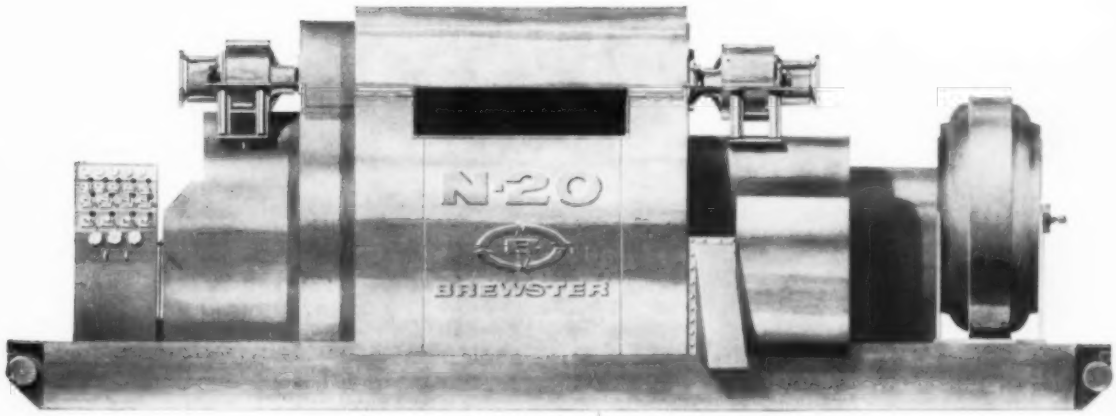

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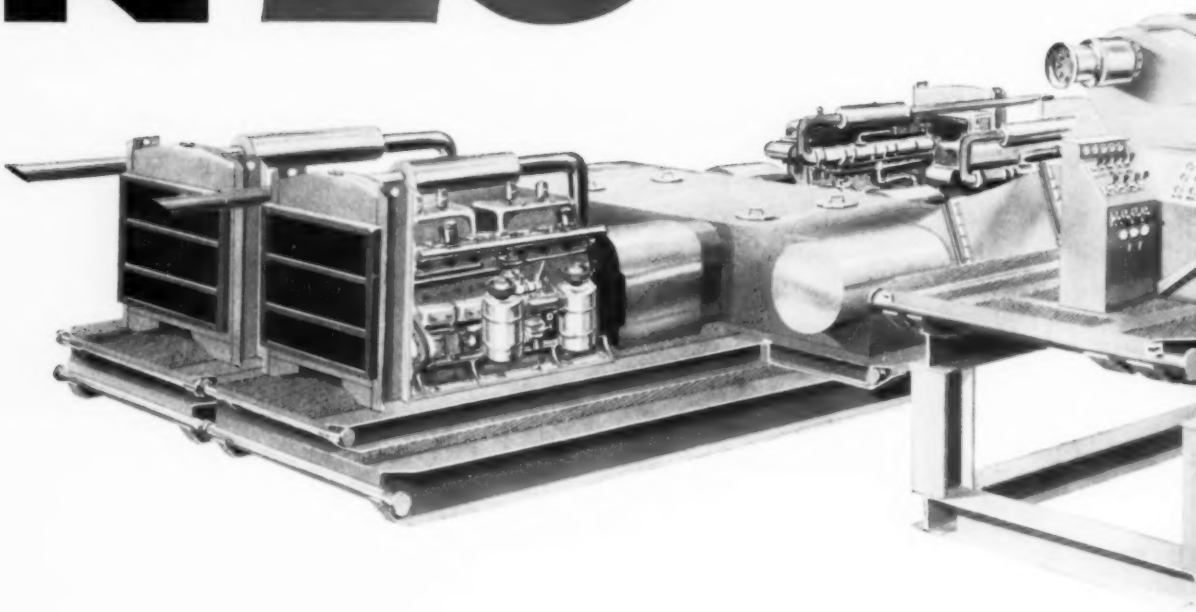
N-20

YOU WANT TO GO... A



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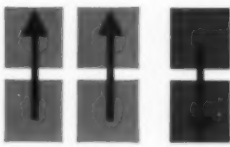

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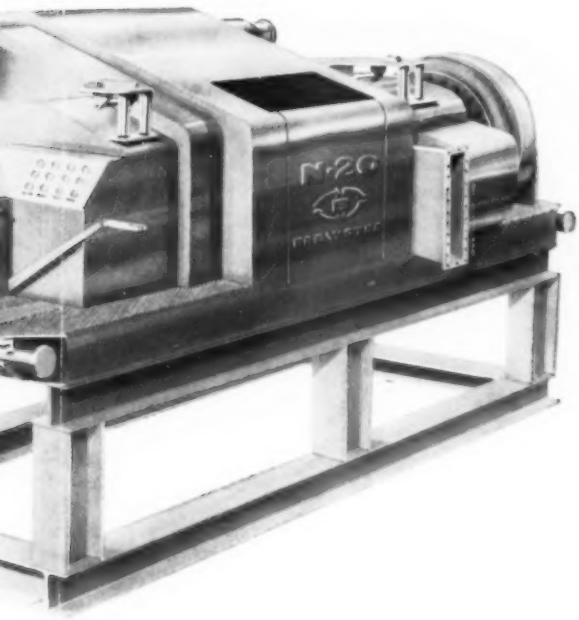

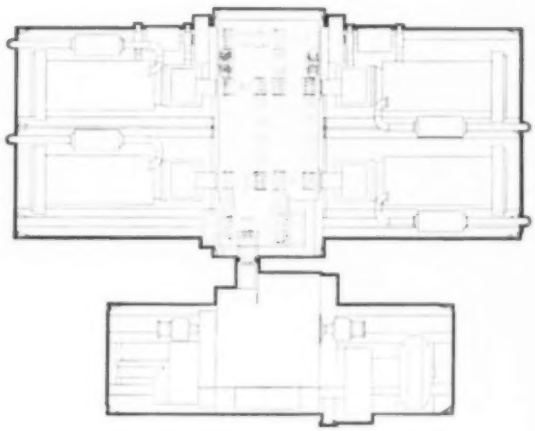

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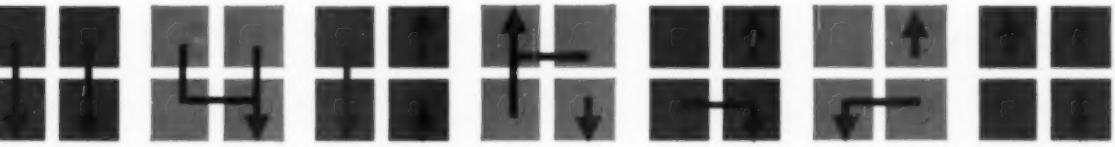

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ound drums . . .
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Specifications

Recommended Available H. P.	2000
Drum Brakes Width x Diameter	12" x 60"
Drum Core Diameter x Length	32½" x 57"
Transmission Forward Speeds	4
Transmission Reverse Speeds	1
Skid	4 Beams 18" x 7' 10" Wide
Overall Height	9' 0"
Overall Width	10' 11⅛"
Overall Length	25' 0"
Approximate Weight (less Hydromatic)	68,000 lbs.

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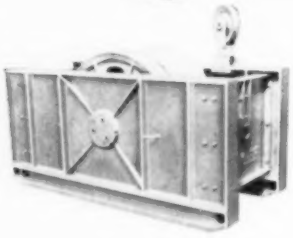

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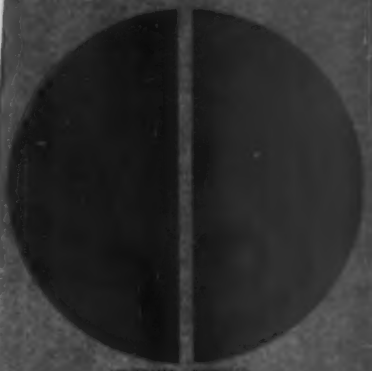

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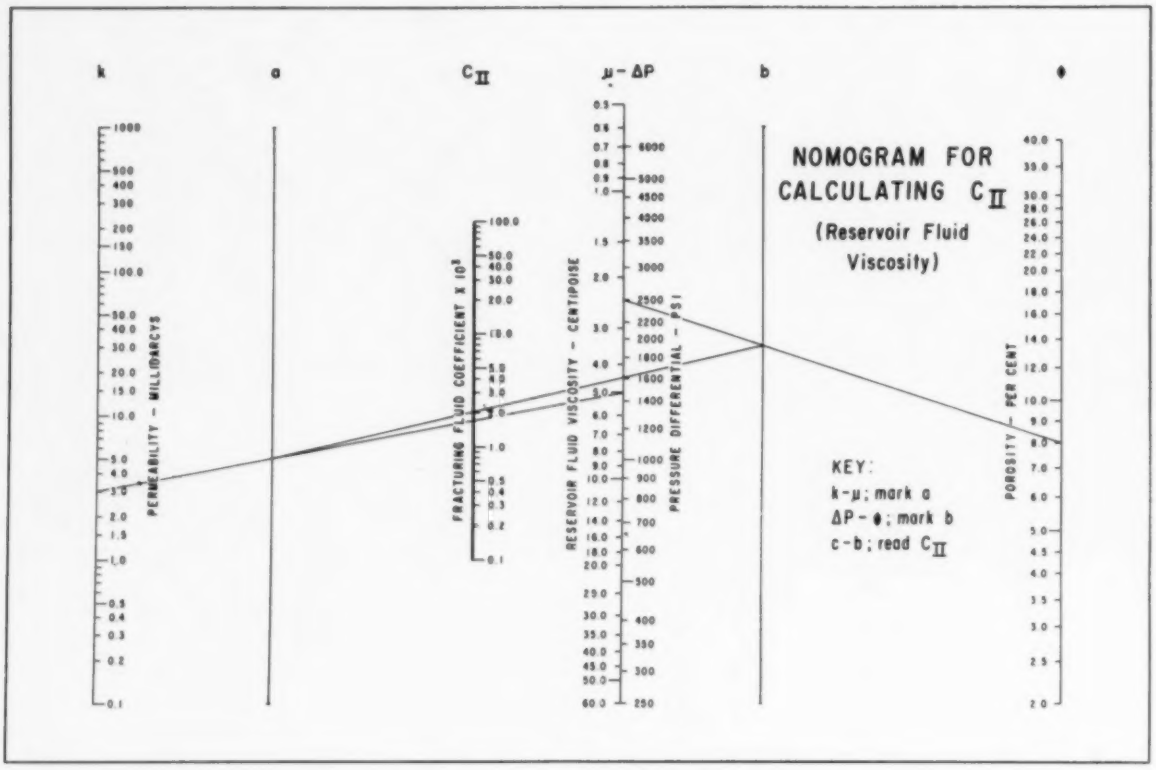


FIG. 2. Nomogram for determination of C_{II}, which relates the viscosity and compressibility of fluids in place in the reservoir to the results of the fracturing treatment.

treating pressure differential, and frac fluid viscosity in the case at hand.

As an example, if the permeability of a formation to be treated is 0.01 darcy (10 millidarcys), the formation porosity is 0.20, the expected treating pressure differential is 1000 psi, and the fracturing fluid viscosity is 500 centipoise, then:

$$C_I = 0.0469 \sqrt{\frac{0.01 \times 1000 \times 0.20}{500}}$$

$$= 3.0 \times 10^{-3}\ \text{ft}/\sqrt{\text{min}}$$

Determination of Data

Permeability and porosity of the well or section to be treated should be determined from the most reliable data available. These figures necessarily always cover a range. The average effective porosity should be taken for calculations. Either an average horizontal permeability or an average vertical permeability should be taken, depending respectively on whether the well can be expected to fracture in a predominantly vertical or a predominantly horizontal plane. The object here is to determine an average effective figure of the permeability through which leak-off will occur.

Average permeability figures from core analyses have been found generally to give satisfactory results. Of course it must be borne in mind that only sections which may actually fracture during a treatment are of interest. Core graphs and other data often include much barren section which will not break down during a treatment. Such sections should not be allowed to influence the average.

The pressure differential ΔP is determined by calculating the bottom-hole injection pressure, i.e. the fracturing pressure of the reservoir, and subtracting the reservoir pressure, or shutin bottom-hole pressure. Bottom-hole injection pressure or fracturing pressure is defined as the surface treating pressure of a well during a fracturing treatment minus the pressure due to friction, plus the hydrostatic head of fluid in the well bore. In other terms, it is the pressure at surface immediately after shutdown from a fracturing treatment plus the hydrostatic head.

Frac fluid viscosity should be determined from available data, and should be taken at the existing bottom-hole temperature.

The variables which make up C_I have been placed on a nomogram for rapid calculation. This nomogram is reproduced in Fig. 1.

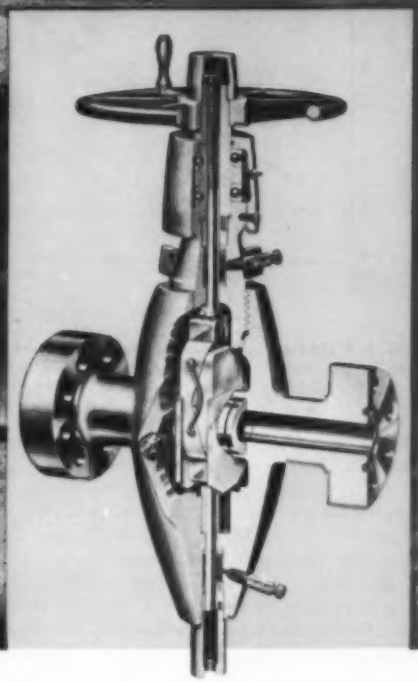
Viscosity and Compressibility Effects of Reservoir Fluids

When the proposed fracturing fluid has physical properties identical, or nearly identical, to those of the reservoir fluid, the mechanism discussed in the section above gives a leak-off rate higher than the true value. Here the rate of leak-off is determined by the viscosity and compressibility of the reservoir fluids.

This is to say that leak-off is retarded, not by frac fluid viscosity as above, but by the necessity for the leaking fluid to compress the fluid already in place. Since the fluid in place is of limited compressibility and has a measurable viscosity, this may be a rather efficient mechanism.

For practical purposes fracturing fluids which fall into this classification are lease crude and water which do not contain fluid loss additives. In such cases the equation for the fluid loss coefficient, here called C_{II}, becomes:

$$C_{II} = 0.0374 \cdot \Delta P \sqrt{\frac{k \phi c_t}{\mu}}\ , \text{ft}/\sqrt{\text{min}}$$



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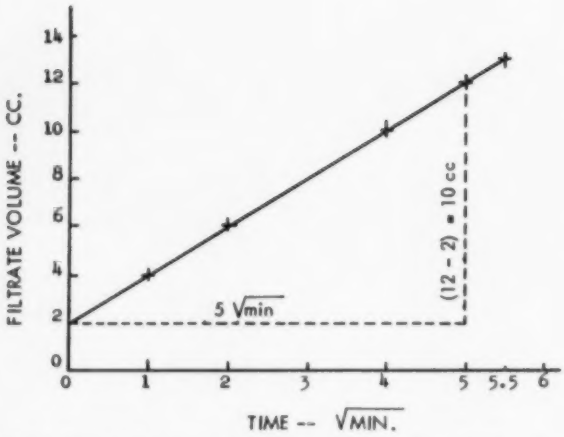


FIG. 3. **Fluid loss** from a fluid containing efficient fluid-loss additives can be represented as a straight-line function of the square root of time.

As before, ΔP is expressed in psi, k in darcys, ϕ in a decimal (%/100), and μ in centipoise. c_f has units of 1/psi.

Unfortunately, the exact value of c_f is not generally known for a particular reservoir. However, within necessary accuracy, it may be considered constant at a value of 1×10^{-5} for liquid-filled reservoirs.

Thus, an example of a case requiring calculation of the C_{II} coefficient is as follows. Treating pressure differential is 1000 psi, formation permeability is 0.01 darcys (10 millidarcys), porosity is 0.20 (20 percent), reservoir and frac fluid viscosity is 2 centipoise, and compressibility coefficient as stated above is 1×10^{-5}. Then

$$C_{II} = 0.0374 \times 1000 \times \sqrt{\frac{0.01 \times 0.20 \times 0.00001}{2}}$$

$$= 3.7 \times 10^{-3} \text{ ft}/\sqrt{\text{min}}$$

Permeability, porosity, and pressure differential values are determined in the same manner as for C_I. Reservoir oil viscosity should be taken at existing bottom-hole conditions.

A nomogram, Fig. 2, has been designed to permit rapid calculation of C_{II}. This nomogram is used in exactly the same manner as the one calculated for C_I. On the nomogram c_f has been included as a constant 1×10^{-5} and need not be considered unless its exact value is known. If it is known, the C_{II} obtained from the nomogram should be multiplied by the factor

$$\sqrt{\frac{c_f \text{ (true value)}}{1 \times 10^{-5}}}$$

A word of caution is in order here. The C_{II} mechanism is concerned only with the viscosity (and compressibility) of fluids in place in the reservoir, and not with the viscosity of the fracturing fluids. In the case, for example, of a frac fluid with a viscosity of 30 cp which is to be used on a reservoir containing oil of 5 cp viscosity, the viscous flow mechanism (C_I) is the one to which to apply the 30 cp frac fluid viscosity. There may be cases in which C_{II} calculated using reservoir fluid viscosity gives a lower rate of leak-off than C_I calculated using frac fluid viscosity. This presents no problem; its proper handling will be discussed later.

Fluids Containing Fluid Loss Additives

The addition of modern fluid loss additives to oil or water creates a third class of fracturing fluids. These fluids build a temporary filter cake or wall on the face of the fracture as it is exposed. While a small amount of fluid must leak through in order to form this wall, once it is formed it presents a quite effective barrier to further leak-off.

As in the two previous cases, the problem is to measure the rate of leak-off; in other words, to obtain a value of C. In this case, it must be determined experimentally. Certain facts may be used to advantage here. Experimental evidence has shown that formation permeability and porosity have notably little effect on the effectiveness of efficient fluid loss additives, at least within the usual ranges of these variables. Thus, they need not be considered in this case, and necessary data can be obtained with high-pressure filter press equipment.

The significant variables in this case are the particular fluid to be used, the type and concentration of fluid loss additive, to some extent temperature, and the treating pressure differential used in previous cases. A single high-pressure fluid loss test adequately covers these factors. The temperature of 125 F used in this test requires that no correction need be made over the usual range of bottom-hole temperatures. Use of the high-pressure test at 1000 psi permits a fairly simple correlation to higher or lower actual differential pressures. This may be done by use of the nomogram described below.

There is one change from the usual fluid loss test procedure. The usual determination is of total volume of filtrate in a given time, cc in, say, 30 min. Since the concern here is with the rate of leak-off, the volume rate of fluid filtration from the press must be measured instead. This determination, and the calculation of a C value from it, is made easier by a simple maneuver. Instead of plotting a graph of filtrate versus time (cc per min) for each time increment throughout the test, filtrate volume may be plotted against the square root of time (cc per $\sqrt{\text{min}}$).

For efficient fluid loss additives such a plot becomes a straight line, as in Fig. 3. The slope of this line may then

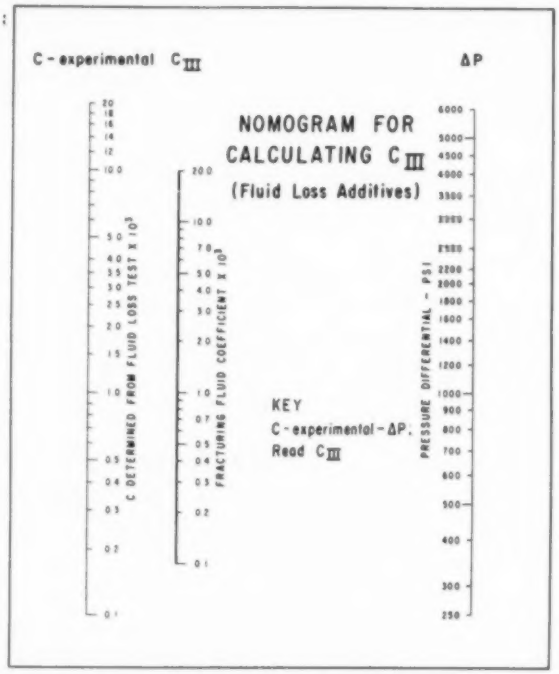
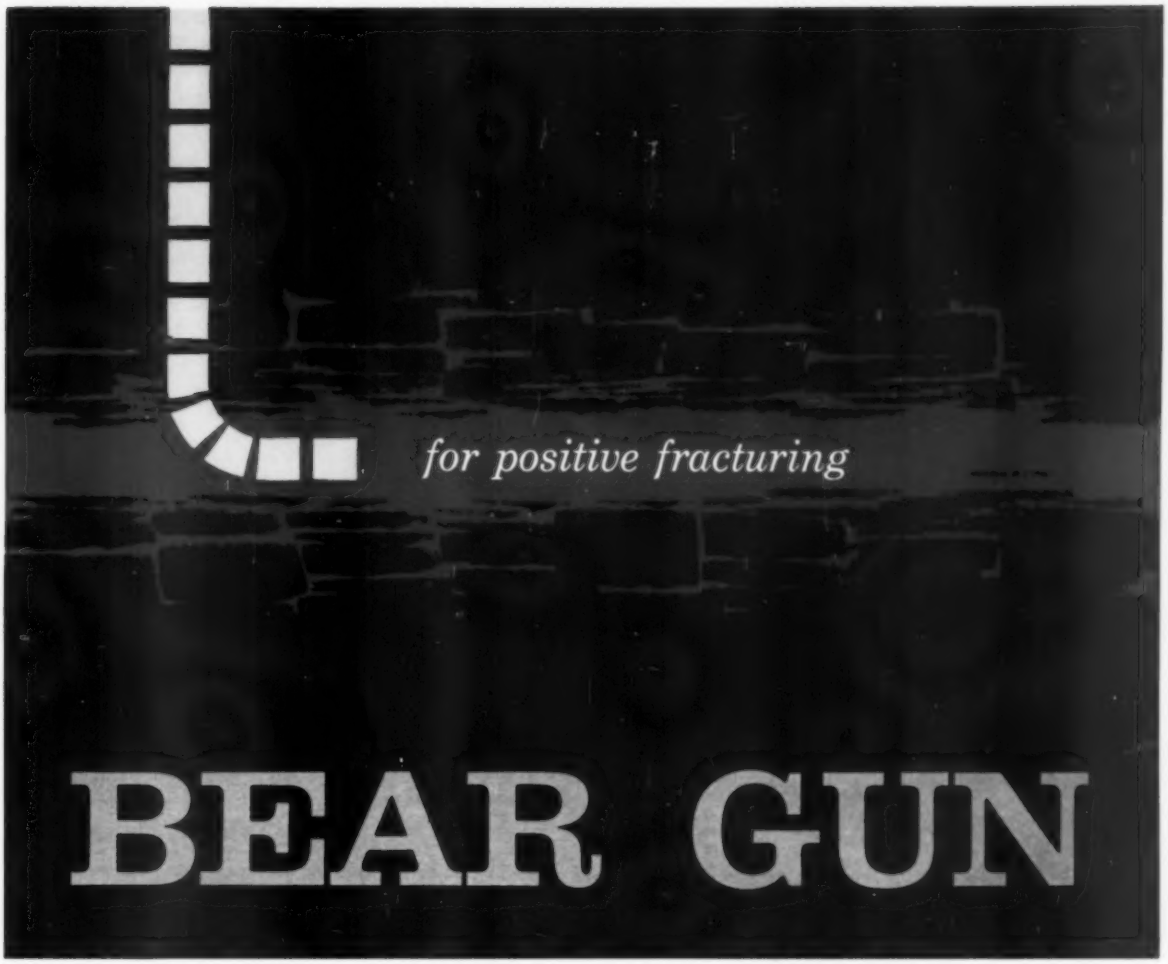


FIG. 4. **Nomogram for determination of C_{III}**, which depends on an experimentally determined value corrected for the actual pressure differential in the well when treated.



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be measured along with the surface area of the filter medium used in the test. This permits writing an equation for the fluid loss coefficient, here called C_{III}, as follows:

$$C_{III} = 0.0164 \frac{m}{a}, \text{ ft per } \sqrt{\text{min}}$$

where m is the volume rate of fluid loss noted above, cc per $\sqrt{\text{min}}$
a is the area of the filter medium, sq cm.

This is to say that C_{III} depends on the volume rate of leakage through the filter and on the area of the filter used.

As an example, an oil plus a fluid loss additive are tested, with filtrate volume readings at 1, 4, 16, 25 and 30 minutes. The graph in Fig. 3 is obtained.

The slope of the line is $\frac{(12-2)\text{ cc}}{(5-0)\sqrt{\text{min}}} = \frac{10}{5} = 2$

The area of the filter paper is 22.8 cm².

Thus,

$$C_{III} = \frac{0.0164 \times 2}{22.8}$$

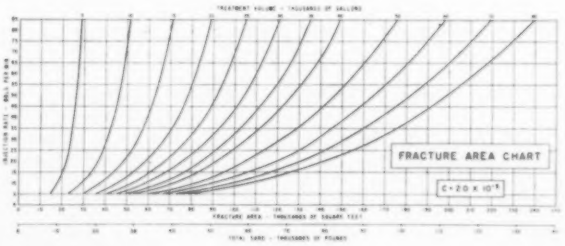
$$C_{III} = 1.4 \times 10^{-3} \text{ ft per } \sqrt{\text{min}}$$

As mentioned above, the C_{III} value obtained from the fluid loss test at 1000 psi should be corrected for the expected pressure differential in the well to be treated. The nomogram in Fig. 4 does this quite simply.

When using some fluid loss additives, there is an element of leak-off which has not been considered so far. An examination of Fig. 3 will reveal this element graphically. The straight line crosses zero time at height of 2 cc. This volume of 2 cc in the example is known as the *spurt loss*. It is the amount of fluid which leaks off freely before any wall begins to form. The coefficient calculations do not take care of this loss; they handle only the loss which occurs after the wall starts forming. Spurt loss is a significant factor with many fluid loss additives. A simple and accurate technique for including this effect will be described.

TO BE CONTINUED

Thus far, an equation has been presented for calculating the area of fracture resulting from a treatment. This equation was found to include a coefficient C, which could be



calculated according to any of three mechanisms. The second and final part of this article, to appear in the May issue of *The Petroleum Engineer*, will illustrate the construction of graphs, as illustrated, based on the area equation and for various values of C.

These graphs, or a nomogram incorporating the same data, will give values of fracture area for any treatment combination. Fracture area is used as a basis for evaluating different combinations. It will be shown that maximum efficiency and economy can be engineered by varying the different factors involved in a fracturing treatment.

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THE use of engineering evaluations by management in the formulation of their many decisions is becoming a problem of selection from a group of possibilities. This particular series is concerned primarily with the evaluation of a multi-pay gas condensate reservoir from its initial discovery to total or economic depletion. In actual operations this would be a team effort of many individuals and the result of their composite efforts would go to make the complete study. Two prime considerations for gas properties are: (1) finding of marketable quantities and (2) proper negotiation of that basic instrument, the gas contract.

Some of the important considerations for gas contractual negotiations are discussed herein from both the standpoint of the producer and from the standpoint of the purchaser or transmisison company.

A series of evaluations were developed and a basic curve was constructed that would allow the management group to make their decision from the pertinent data only and not be burdened with the rigorous calculations involved in the evaluation procedure.

Sixth Largest Industry

After World War II with the advent of the major transmission lines serving the East Coast, the Midwest and now the Pacific Northwest, gas has taken on greater and greater value. It is now the sixth largest industry in the United States and is supplying a substantial percentage of our total fossil fuel demands.

The overall mushrooming growth and history of the gas industry has been covered in considerable detail by others and will not be rediscussed in this study. The specific economics of evaluating condensate reservoirs from both the standpoint of the seller and the buyer have been treated separately. This series is an attempt to discuss many of the variables that are important to the combined operations of producing, processing, and transmitting of natural gas.

A study of this type before it comes to the final attention of management is quite obviously a joint effort. Complete evaluations require the expert and competent work of many different individuals and departments within a company. The departments of land and legal, drilling, engineering, gas, tax, production, economics and valuation, and others, all have definite functions and responsibilities in such a study. The number and make up of the departments involved in an undertaking of this type will depend upon the size, scope and policy of the company.

In developing the evaluation methods to be presented in this series, it was realized that this is only one of a number of possible solutions. If, in presenting this study, some of the major pitfalls are pointed out that might be later avoided by anyone doing this type of work, the basic purpose of this paper will have been accomplished. No one phase will be covered in great detail, but the comprehensive list of references

TABLE 1. Cost Comparisons for Single, Dual and Triple Completions.

Depth			12,000′	8,000′	4000′
Drilling and Casing Only					
Well			$ 75,000	$ 45,000	$20,000
Mud			25,000	10,000	4,000
Casing			60,000	30,000	14,000
Cementing			5,000	3,000	1,000
Formation Evaluation					
Logging			4,000	2,000	1,000
Coring			4,000	1,000	500
Mud Logger			3,000	1,000	500
Sub Total			$176,000	$ 92,000	$41,000
Completion Cost	Single	Dual	Triple	Single	Single
Perforating	800	1,400	2,000	600	600
DST's	800	1,600	2,400	800	800
Tubing	15,000	25,000	31,000	10,000	6,000
Packers	600	3,700	6,000	600	600
Circulating Eqpt.	900	2,000	4,000	800	700
Tree	2,500	7,500	8,500	2,000	1,500
Flow Line	2,000	4,000	6,000	2,000	2,000
Rig Time	2,000	4,000	7,000	1,500	1,000
Contingencies and Supt.	14,400	19,800	22,100	5,700	2,800
Sub Total	39,000	69,000	89,000	24,000	16,000
Total	$215,000	$245,000	$265,000	$116,000	$57,000

The author originally presented this series at The School of Gas Technology held October, 1958, at Kilgore College, Kilgore, Texas. This school is held annually and is sponsored by the Petroleum Extension Service of The University of Texas.

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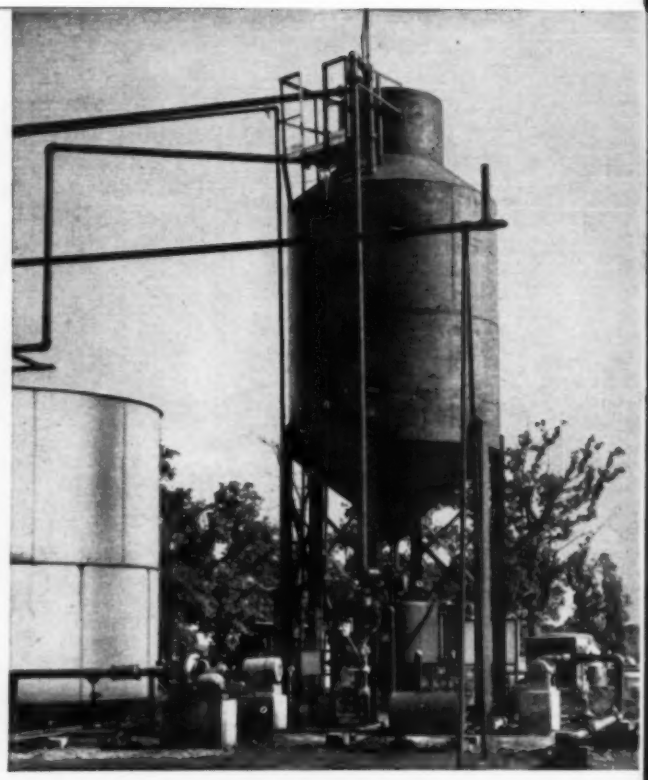
LEASE AUTOMATIC CUSTODY TRANSFER

Since lease automatic custody transfer is the key to complete automation at the wellhead, and hence the key to cost reduction, the dependability of the LACT equipment is particularly important. Graver offers two thoroughly proved integrated production systems: Type I features intermittant flow, with capacities from 1150 to 5850 bbl./day. Type II provides continuous flow in capacities from 2000 to 5850 bbl./day. Ask for folder describing the dependable Graver systems.



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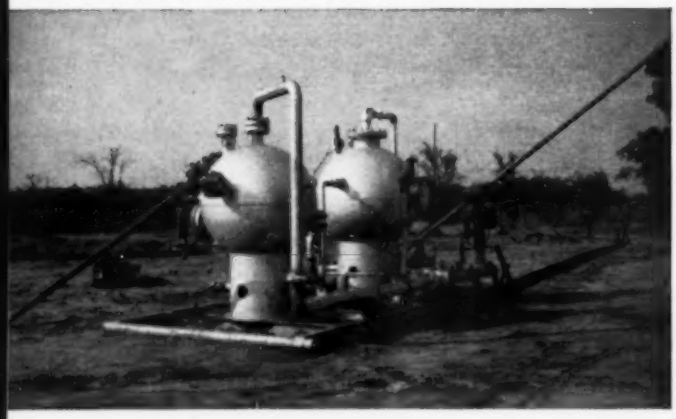

Above TWO-STAGE SPHERICAL SEPARATOR UNIT

A favorite when skid mounted as above for well-testing, this separator unit consists of spherical separators with capacities of 1200 lb. W.P. and 125 lb. W.P. and a gas meter run. Such units are rented for testing prior to installing permanent equipment.

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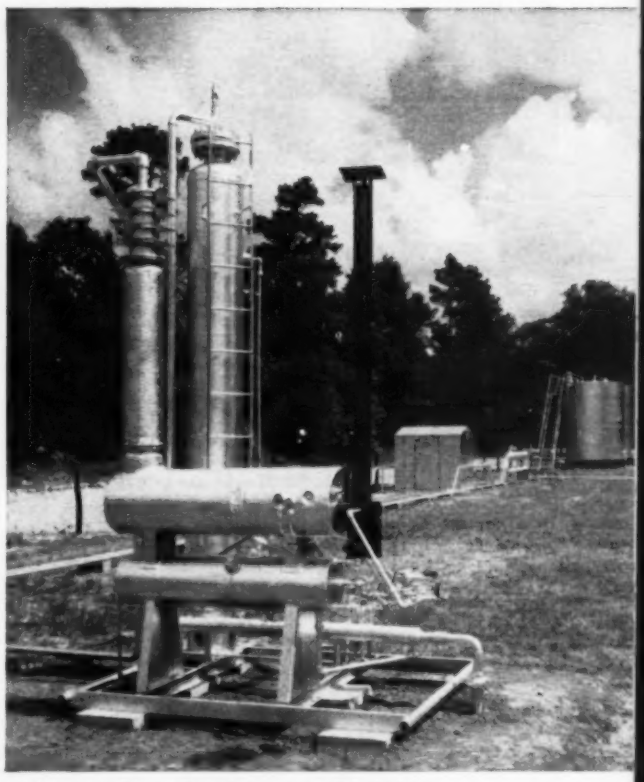

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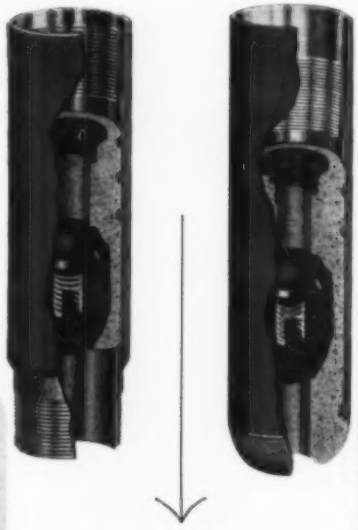

2 The concrete nose guide... with a more generous radius extending from the steel coupling... made of special formula, higher strength concrete... for greater efficiency and durability in guiding casing safely to bottom.

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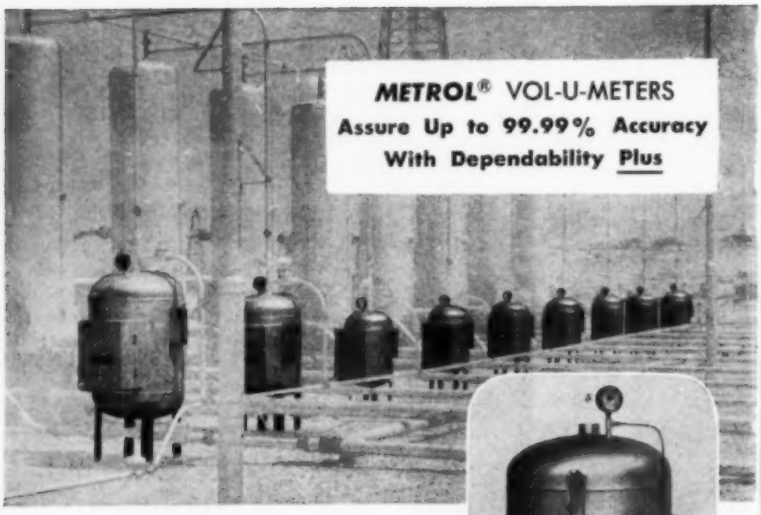

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will allow those interested, to pursue certain phases of the study in greater detail.

This paper is subdivided into steps that are more or less in chronological order for the logical development of the gas prospect.

Geological and Geophysical Considerations

Prior to any land or leasing activity a preliminary study will be instigated by the exploration department. This may be the result of a regional study or it may be the result of a tip brought in by a scout or landman.

The exploration manager then decides how to evaluate the prospect. He checks with his area geologist and geophysicist for their ideas. In a survey undertaken by the AAPG it was found that by using the technical guidance of geologists and geophysicists that the success ratio was over double that of non-technically located prospects.

A definite program is formulated, and a detailed geophysical program and subsurface study gives indications that the area in question is productive. A program such as this would be difficult to evaluate, but for the acreage in this study let us assume that it is $10 per acre. If the total acreage in the play was

Series Author

William C. Goodson

William C. Goodson is a member of the newly formed gas department of Republic Natural Gas Company. Bill joined Republic in 1954 and in 1957 he was promoted to Senior Reservoir Engineer and transferred to the Dallas office. From 1950 to 1954, he was employed by The Atlantic Refining Company specializing in gas condensate reservoir engineering and field processing.

After receiving a B.S. degree in chemical engineering at Texas A&M he worked at Humble's Baytown refinery for one and one-half years. He then taught engineering subjects at Texas A&M and Kilgore College for two years.

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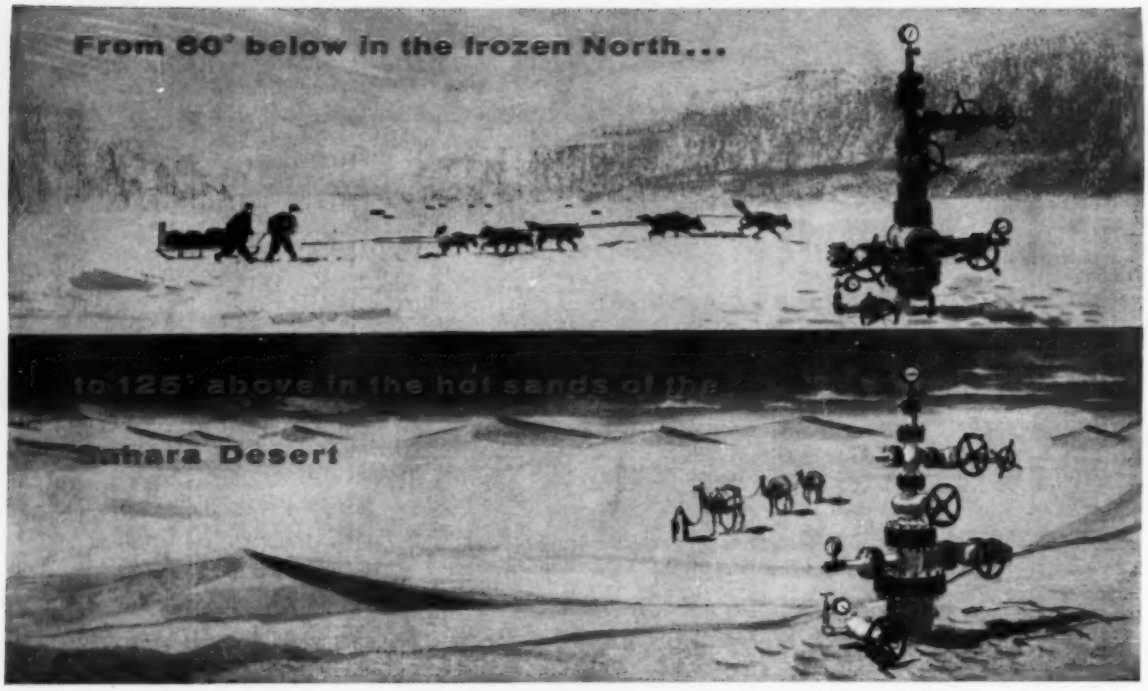

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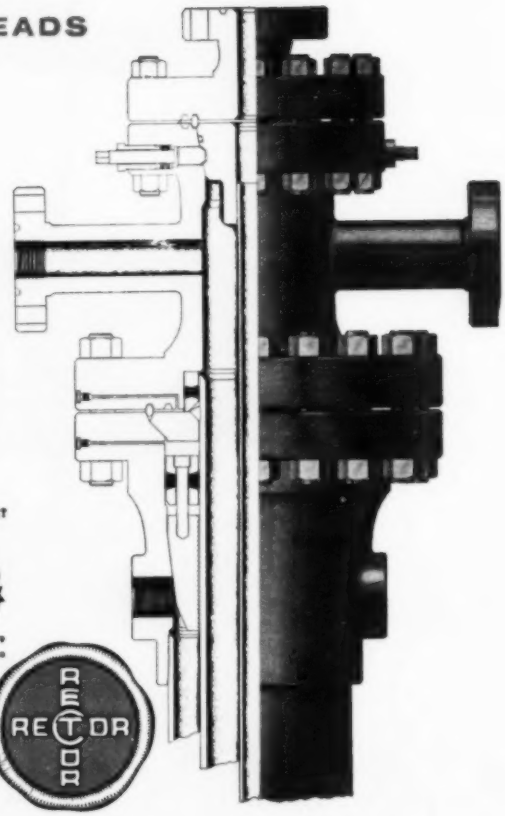

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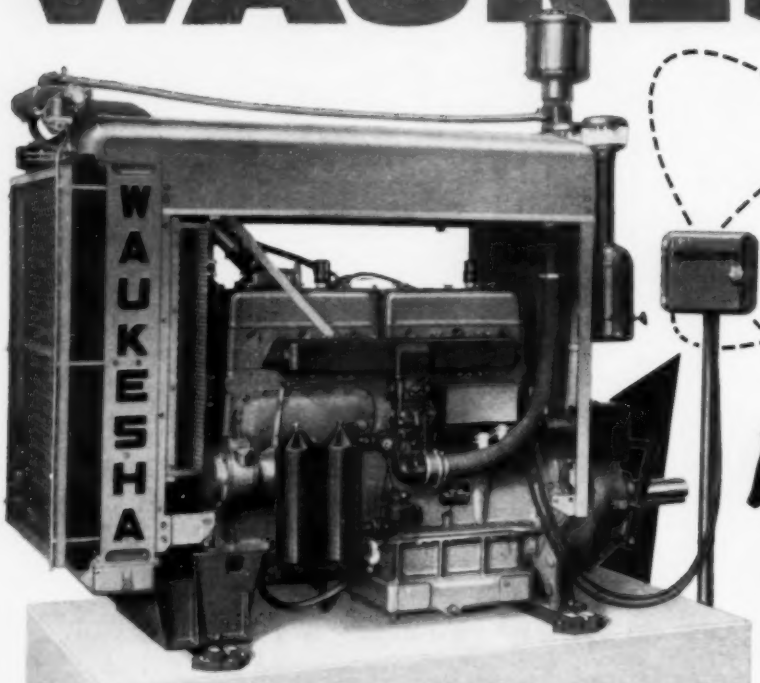
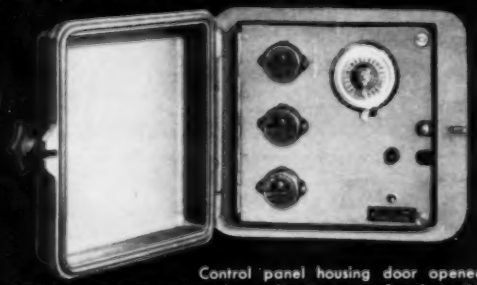
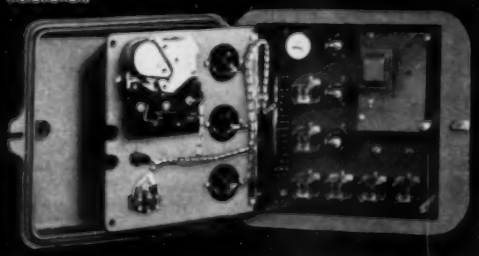


Engomatic POWER CONTROL SYSTEM

Typical Waukesha *Engomatic* Control System installation on a Waukesha Long-Life Oil Field Unit. Note control panel can be mounted in any convenient position.



Control panel housing door opened, showing heavy cast construction, dust and moisture proof seal, starting reset, and time-cycle controls for an *Engomatic* pumping control installation.



Panel open, showing wiring harness, sealed relays and other electrical components, all of highest quality, and designed for long life and easy replacement.

423

The Waukesha *Engomatic* Control System meets the demand for internal combustion engine automation. All operation is independent of outside power. It is fully protected with safety shutdown devices and has visual indicators and manual resets, and functions with engines using all standard fuels. Operation can be controlled on a time-cycle basis; by remote control; liquid levels or temperatures; or by any signal peculiar to the equipment involved. Send for Bulletin 1731.

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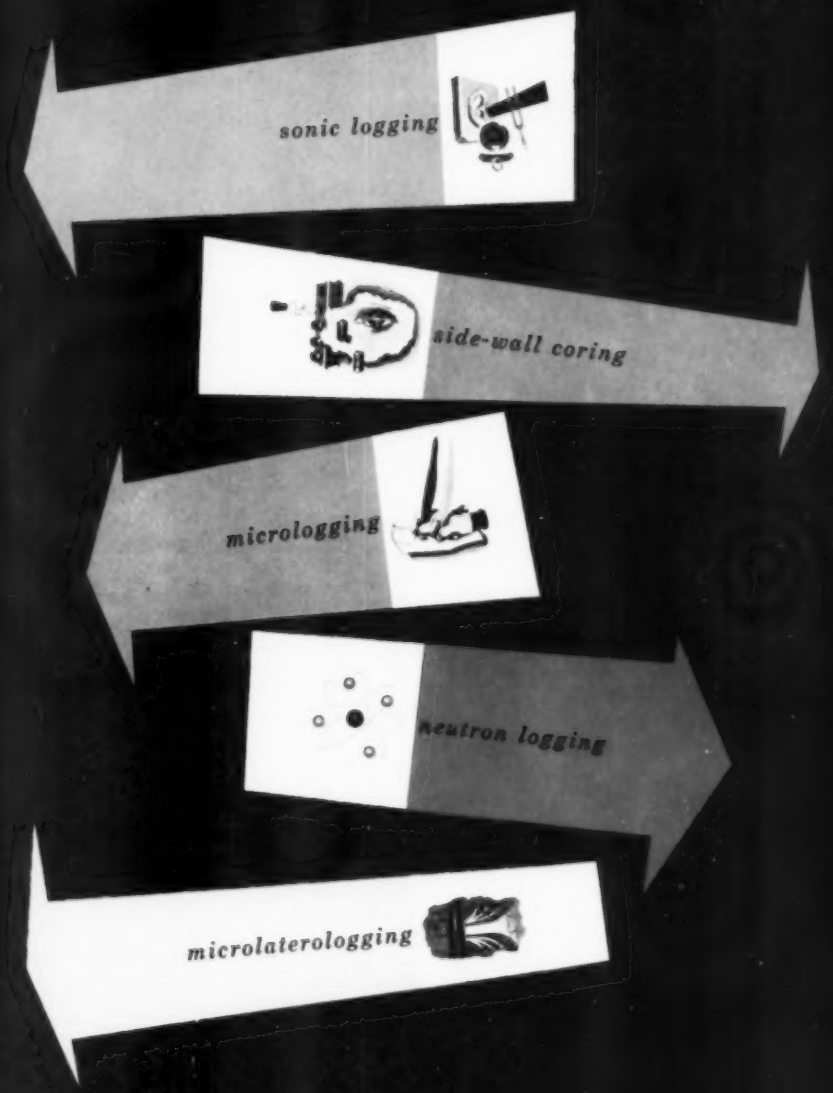

Five methods of porosity determination

by SCHLUMBERGER

If you are lacking porosity data, you are not getting full value from your logging program. Porosity is a necessary element of reservoir analysis. Establishing the presence of oil, the degree of saturation, and the producibility of the formation all hinge on knowledge of porosity.

But there is no single universal logging method for getting this basic information. The best way in any area may depend on reservoir characteristics, on borehole conditions, or on the additional data which each method contributes. Sometimes the inclusion of two porosity devices in the logging program gives information on lithology and fluid content that no single log can achieve. *That's Why Schlumberger Offers Five Methods of Porosity Determination.* Your Schlumberger engineer can tell you which to use in your drilling area. Of this you can be sure: **The Best Way is The Schlumberger Way.**

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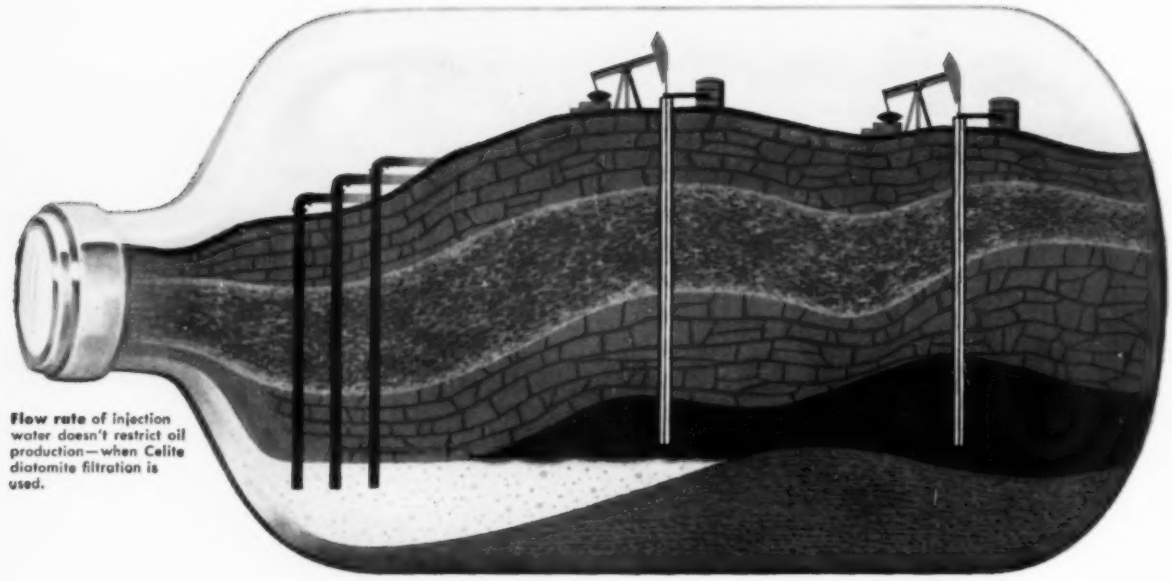

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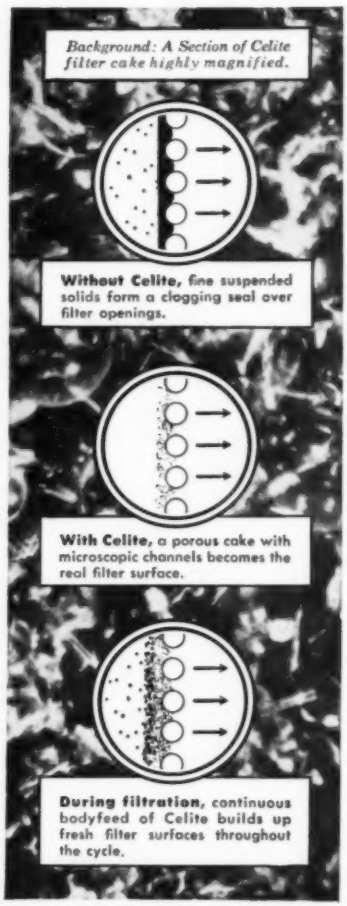
Background: A Section of Celite filter cake highly magnified.
Without Celite, fine suspended solids form a clogging seal over filter openings.
With Celite, a porous cake with microscopic channels becomes the real filter surface.
During filtration, continuous bodyfeed of Celite builds up fresh filter surfaces throughout the cycle.

JOHNS-MANVILLE JM JOHNS-MANVILLE PRODUCTS

20,000 acres the initial cost for the preliminary study would be $200,000.

Land and Leasing Important

After and during the preliminary study by the exploration department, which of necessity has been kept as secret as possible, the land department begins its operations. Through the use of its own people and competent lease brokers, its job is to secure as many acres of the land in question as economically as possible. The value of the acreage depends on several factors:

1. Proximity to known production.
2. Amount of activity in the area.
3. Trading ability of the contacting landmen.

The first two items are fixed, but the trading ability and acumen of the land department will determine to a large extent the success of the venture at the outset.

For the particular area in this study the acreage lease cost will be assumed to be $50 per acre. The leases are signed by independent lease brokers and this expense and commission may run as high as 10 percent of the lease cost. For the area under consideration this would require an expenditure of (20,000 acres) ($50) (1.10) = $1,100,000.

The provisions in the lease may provide for a consideration as high as 1/6 royalty and an overriding royalty of 2 percent for the broker who brought the original play to the attention of management.

Well Spacing and Drilling Density Affect Profits

Many papers and studies have been made on the subject of well spacing and density for both oil and gas reservoirs. Humble has conducted several studies of this type on gas reservoirs. A recent paper by Rupert Craze of Humble given at the Spring Gas Techonology Symposium in Shreveport concluded that wider spacing than normally thought feasible is advocated in gas reservoirs. Any excessive drilling is obviously an economic waste; conversely, any program that does not call for adequate wells delays depletion of the reservoir to such an extent that the profitability is diminished. For purposes of this paper, it is assumed that there will be three productive reservoirs — 4000, 8000, and 12,000 ft sands. The 4000 ft reservoir will require a density of 320 acres per well, and the other two sands will require a density of 640 acres per well. It is further assumed that 6400 acres of that studied will be productive.

Based on these considerations, 20 completions will be required to deplete the 4000 ft reservoir and 10 each for the 8000 and 12,000 ft reservoirs.

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A NEW RECORD

.....25,340 ft.

University EE #1, Pecos County Tex., Oct. 1958

The **Knowlton Vertical Set Liner Hanger** was selected to successfully hang 2642 ft. of 5-in. liner, 12 ft. off bottom, at a record depth of 25,340 ft.

Knowlton's successful field experience with deep and difficult wells is due largely, to superior tool design and fabrication. The Vertical Set principal embodied in most Knowlton tools, was a "must" for this record breaking well.

The **Knowlton Vertical Set Liner Hanger** can be set and unset by vertical motion only, at any depth and as often as desired.

Ask your **Knowlton** representative for additional data describing the advantages of Knowlton Vertical Set Packers, Anchors and Hangers.

Sold at National Supply Stores.

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Production Fundamentals

Plan Program Early

To properly evaluate the reservoirs, a well coordinated formation evaluation program should be established as early in the exploration analysis as possible. The exploration manager should coordinate the program with the geophysical, geological, engineering, and production departments to assure that as orderly a program as possible is utilized. The use of proper mud, adequate drilling rigs, mud logging units, selection of intervals to be cored and logged, possible zones to be drillstem tested should all be discussed and evaluated. It is beyond the scope of this article to discuss the details of formation evaluation. For further study along this line, a symposium book presented at an AIME Study Group meeting in 1955 in Houston is highly recommended. The basic purpose of all formation evaluation programs should be to decide the productive intervals and to give estimates of what type fluid and how much these intervals produce.

Drilling, Completion Costs

After deciding on the number of wells and the formation evaluation program, the next step is to estimate the drilling costs and decide on the completion procedure. Recently dual and triple completions utilizing two and possibly three strings of tubing have been used quite extensively in the Gulf Coast. Many equipment companies now have available down-the-hole equipment that makes multi-completion wells easier to complete and operate. The selection of the type of completion is a matter of economics and anticipates future workover problems or difficulties. To reach a decision the economics of single, dual, or triple completions will be studied and compared in Table 1.

The cost comparison could be made by the following methods:

1. Single Completions

10 at 12,000′	=	(10)	(215,000)	=	$2,150,000
10 at 8,000′	=	(10)	(116,000)	=	1,160,000
20 at 4,000′	=	(20)	(57,000)	=	1,140,000
			TOTAL	=	$4,450,000

2. 10 Duals (12,000′ and 8,000′) and 20 Singles

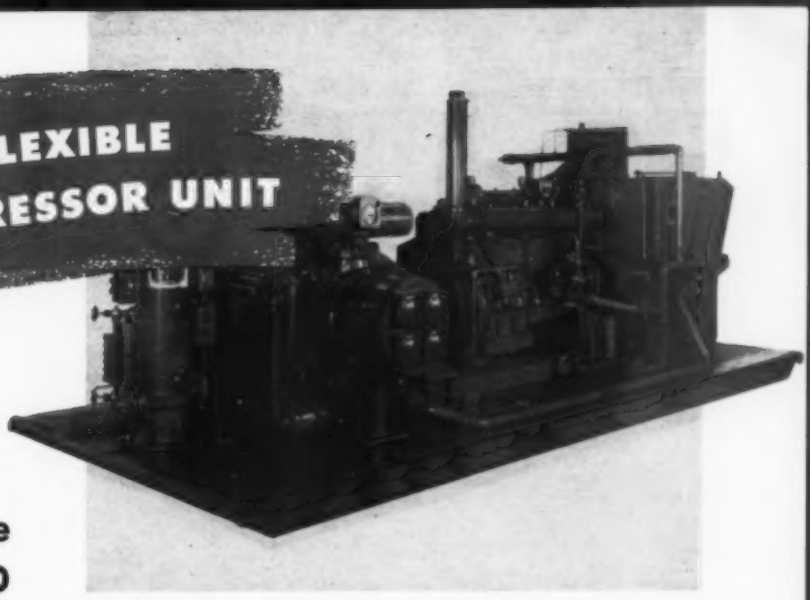
10 at $245,000	=	$2,450,000
20 at $ 57,000	=	1,140,000
TOTAL	=	$3,590,000

3. 10 Triple Completions and 10 Singles at 4000′

10 at $265,000	=	$2,650,000
10 at $ 57,000	=	570,000
TOTAL	=	$3,220,000

Considering that possible future operational problems will not be too great, the 10 triple completions and 10 single completions would probably be the best approach. These wells plus six-12,000-ft dry holes to fully outline the field would result in a total of 26 wells to develop the field. At a cost of $150,000 per dry hole the total drilling and development costs would amount to $4,120,000.

NOW.... A MORE FLEXIBLE PORTABLE COMPRESSOR UNIT



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INGERSOLL-RAND

CONTROLLED CLEARANCE "LINER TYPE" LOW STAGE COMPRESSOR CYLINDER—

THE
WILSON SUPPLY
INGERSOLL-RAND
Packaged, Portable
COMPRESSORS

This is a companion cylinder to the Ingersoll-Rand high pressure Liner-Type Cylinder — and makes possible a portable field compressor unit more flexible than any unit previously available.

With "controlled clearance" this cylinder is capable of handling any application where the discharge pressure is between 150 lbs. and 500 lbs. It is necessary only to change liners and/or clearance.

This new cylinder gives sustained high efficiency and trouble-free performance through the use of Ingersoll-Rand Type "A" channel valves.

Remember — a liner costs a lot less than a new cylinder, and can be changed in the field with minimum shut-down time.

For your field compressor needs contact
Wilson Supply Company, Compressor Division,
P. O. Drawer 19, Houston, Texas

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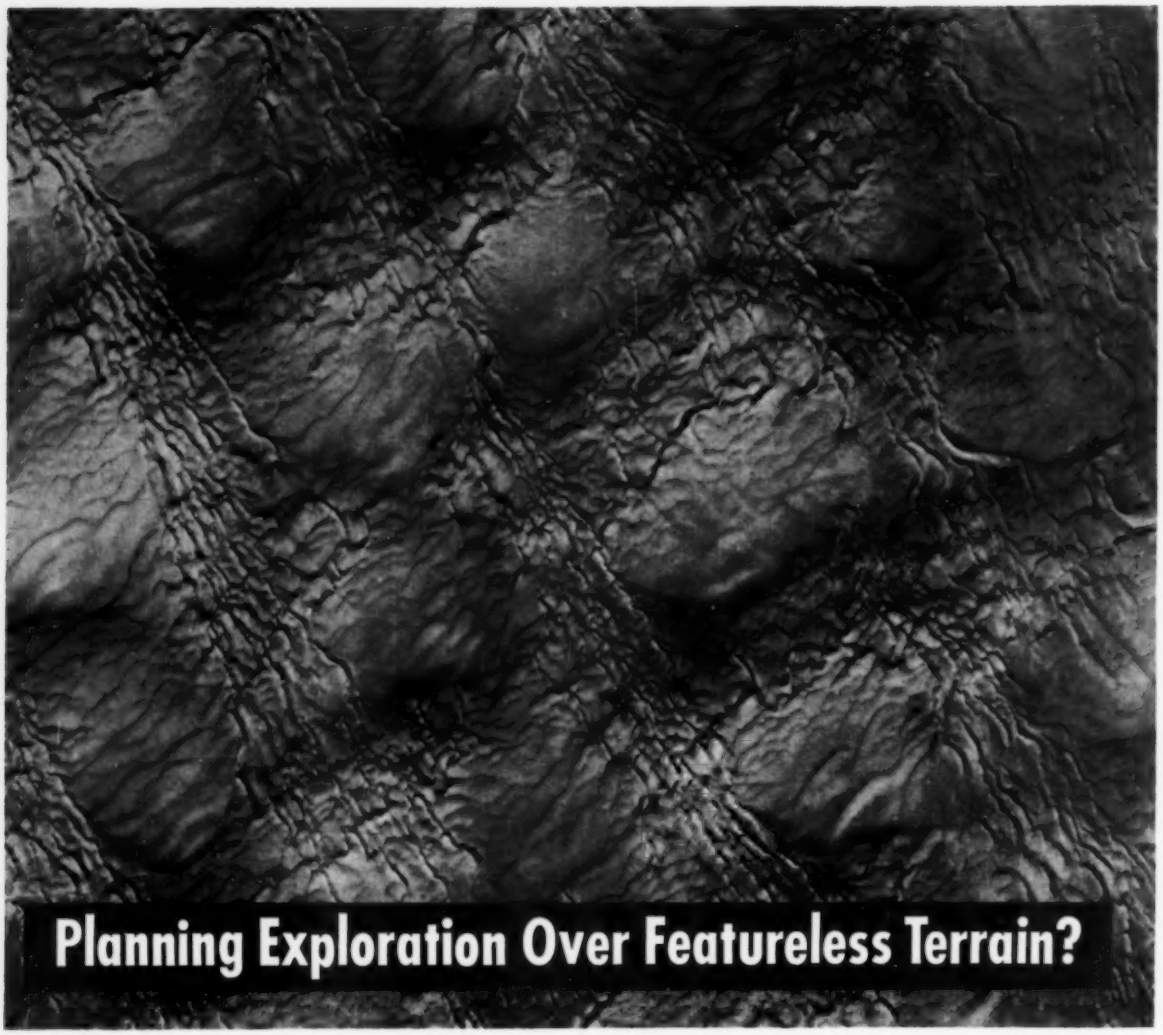

Planning Exploration Over Featureless Terrain?

It's now possible to get dependable aerial surveys over featureless areas. Terrain once considered too difficult can be explored. Now AERO offers airborne magnetometer surveys guided by RADAN® navigation systems.

Tested in more than 40,000 square miles of desert surveys, this new radar Doppler aid measures ground distances within 1 or 2 parts in 1,000. Drift is charted within 0.1°. No maps, photos or ground stations are required.

With this new system, AERO can make magnetic surveys *before* or *during* the mapping program. Delays for completion of aerial photos are avoided. What's more, reconnaissance over unexplored country is as dependable and technically excellent as lines flown in well-mapped areas.

Costs for this Doppler guidance are $1 to $2 per line mile. It reduces total costs of radio-guided surveys by 50% or more.

Get complete information. Write Dept. 106 for EXPLORATION OVER FEATURELESS TERRAIN with RADAN® NAVIGATION. It reports costs, accuracies, other important data.

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Heavy hauling made easy! Up front is a Mack-mounted cementing rig in action. Behind it is the world's largest mobile rig, operating in Venezuela and completely Mack-drawn.

Whatever the oil-field hauling job—rigs, draw works, casing, boilers, power units . . . . Macks have the guts and go to get there first . . . . with the most . . . . and at lowest costs.

How hard do you think about cutting hauling costs?

Ever figure the added returns that a really strong, long-lived truck can give you? A truck that truly measures up to the non-stop abuse of oil-field terrain . . . and goes on working year after year with only routine servicing? There *is* such a truck—and Mack's the name. For over fifty years Macks have been famous—in every hauling field—for their extended earning life.

What's behind the extra stamina . . . the longer life of Macks? Mack frames, axles and suspensions—the most rugged in the business. Mack-built transmissions—with exclusive gear design and use of the finest metals obtainable. Mack Thermodyne® diesel or gasoline engines—units that have been known to run 400,000 miles . . . 500,000 miles . . . and even further without a major overhaul. Mack Balanced Bogies—tandem rear axles with matchless traction over terrain conditions that mire in other makes.

Let your Mack branch or distributor help you figure out how much Macks can save you over the next five years. Ask them to show you how Mack can custom-assemble the units that are *right*—in capacity, basic strength and long life—for your operation. And be sure to ask for the names of other Mack users as well. Mack Trucks, Inc., Plainfield, New Jersey. In Canada: Mack Trucks of Canada, Ltd.

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MACK
FIRST NAME FOR
TRUCKS

EXPLORATION ACTIVITIES

KENTUCKY

Seminole Oil Gains Cincinnati Arch Property

Seminole Oil and Gas Corporation has purchased substantial working interests in approximately 6000 acres of oil and gas leases astride the geologically famous Cincinnati arch in Taylor, Green, Laurel, Allen and Simpson counties of the state of Kentucky.

Drilling operations are scheduled to get under way in June. Oil and gas operators, including several majors, have been extremely active in the area.

Tysco design, engineering, sales, and service departments operate on the basis that quality products and dependable service establish satisfied customers. To assure that its products and service are the best available, Tysco functions as a flexible company. One that easily adapts its facilities and personnel to your specific oil and gas process equipment problems. A company that delivers sound, economical solutions to those problems. When you specify Tysco process equipment, you are sure that each unit, from the smallest component to the major vessel, is designed, manufactured, installed, and serviced to help you get more from each process equipment dollar.

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KANSAS

White Eagle Commences 10 'Cat Program in Kansas

White Eagle Oil Company, Tulsa, has spudded the first of 10 wildcats in an exploratory program along the Barton Arch Trend in Central Kansas. Associated with White Eagle in the drilling program is Michi-Kan Oil Ltd., a Michigan organization formed to participate in this venture. The 10 prospects which will be drilled in the course of the program are composed chiefly of Lansing-Arbuckle tests and are located in five Kansas counties. The first well spudded is the White Eagle No. 1 Barbara Apel, SE SE NE 21-25S-16W, Edwards County, which will be carried to 4750 ft to test potential pay zones from the Lansing through the Arbuckle. This prospect is located two miles southwest of Kinderhook Sand gas production in the Edstaff pool, two miles south of Lansing gas and a mile and a half northwest of oil production from the Conglomerate and Kinderhook Sands in the Wil pools.

TEXAS

Husky Scores in Martin County Prospector

Husky Oil Company announced a new oil discovery in Martin County at its Knox No. 1, which flowed 37 deg oil on test at the rate of approximately 200 bbl per day. Production is from the Dean formation through perforations at 9128 - 9146 ft. Husky plans further testing prior to running the state potential test on the well.

The discovery is located on a 3386 acre lease in which Husky holds a 50 percent net working interest. Other interest holders are Herman Brown and Temple Oil Company.

Sunray, Sam Sklar Hit In Cass County; Begin Offset

Sunray Mid-Continent Oil Company and Sam Sklar have made an apparent new oil field discovery at the wildcat No. 1 Lemmon in the West Lodi area of Cass County.

The well flowed at the daily rate of 190 bbl of 42 deg oil through 20/64-in. choke after perforations at 6162-72 ft opposite the Anhydrite Stringer formation. Tubing pressure was 125 psi, casing pressure 750 psi, gas-oil ratio 468 to 1.

The well is located 645 ft from the east line and 330 ft from the south line of the A. Robertson survey, Abstract 588 in the O. W. Lemmon tract.

Remedial Versatility

WITH HALLIBURTON "DM-DC" DRILLABLE SQUEEZE PACKERS/ BRIDGE PLUGS

Simple design . . . easy to run in and set on tubing, drill pipe or wire line—for general application in any well . . . regardless of depth or pressure; effecting a positive fluid shut-off from either direction . . . establishes the "DM-DC" Drillable Squeeze Packer as the industry's most versatile tool for either squeeze cementing, or as a bridge plug.

These high quality and dependable squeeze packers are used to form an effective plug in "squeezing" cement or fluid below packer through tubing or drill pipe at any predetermined point behind liner or casing; around shoe or shoe joint. Can also be used as casing bridge plugs for preventing movement of fluid through packer from either direction.

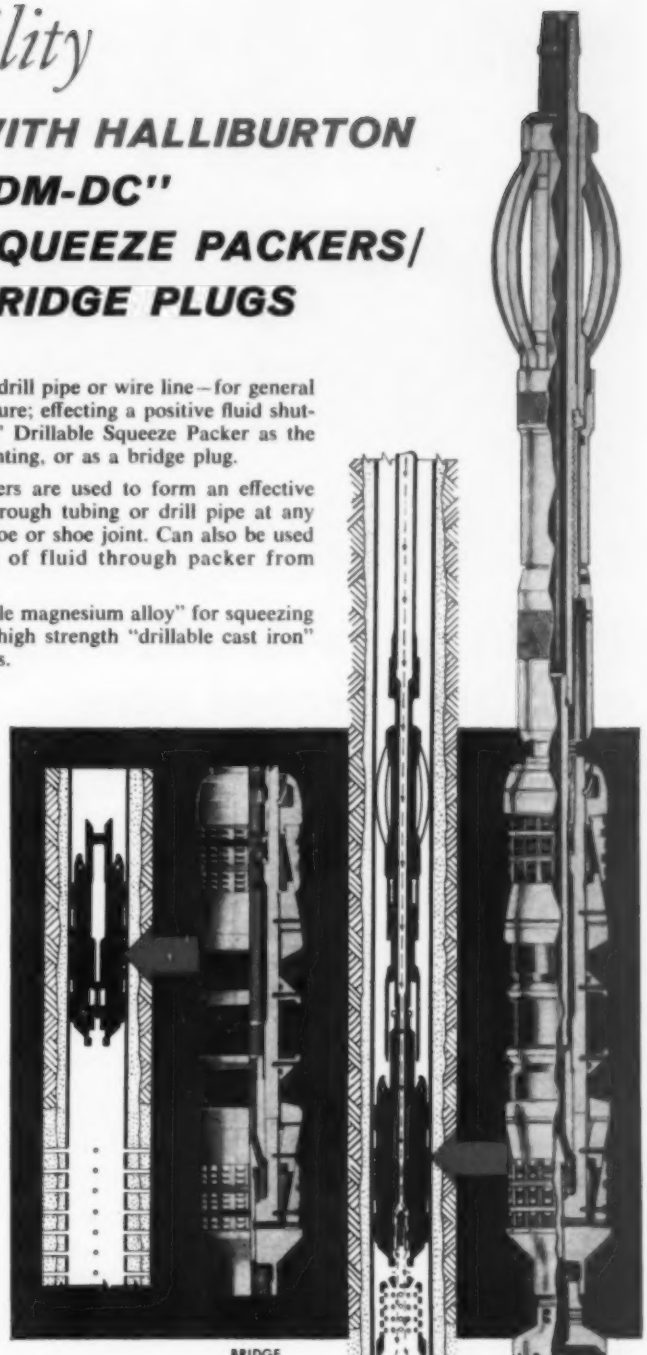
Type "DM" is constructed of high strength "drillable magnesium alloy" for squeezing or temporary bridge plugs . . . type "DC" is made of high strength "drillable cast iron" for squeezing or permanent or temporary bridge plugs.

Several additional advantages and outstanding features of this packer are:

- Tubing and circulating valve are free from packer before squeezing begins; can be picked up as desired between stages.
- Tubing and circulating valve can be removed from well any time for tubing leak repairs; then re-enter the packer.
- No strain is taken on tubing while squeezing.
- Packer will withstand *any* pressure that can safely be put on casing or tubing.
- The back pressure valve is the sealing cup type which provides a more positive seal.
- Can be set with Halliburton Electrical Wire Line Setting Tool, and the "DCM" Cup Type Setting Tool . . . methods that afford substantial savings in time, wear on casing, tubing, drill pipe and rig.

A shut-off sealing plug to prevent contamination, may be pumped down 2" or 2½" tubing, between fluids, and shut off in the packer.

A "DM-DC" Squeeze Packer may be converted into a bridge plug by dropping a sealing plug down through the tubing or installing a permanent sealing plug before running into well.



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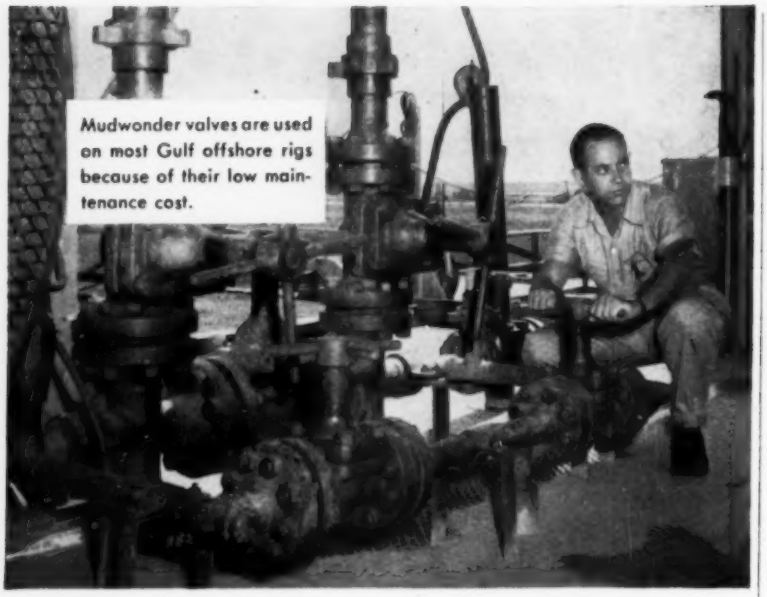


Mudwonder valves are used on most Gulf offshore rigs because of their low maintenance cost.

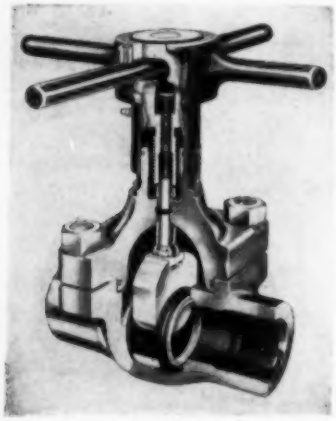
Offshore and on-shore Mudwonders* outperform other mud valves

In major drilling fields around the world, offshore and on-shore, Rockwell-built *Mudwonder* valves are preferred by rig operators because of the many important operating advantages these sturdy valves offer.

EASIER TO INSTALL AND MAINTAIN . . . Specially selected materials give *Mudwonder* parts exceptionally long, trouble-free service life. Resilient buna-N inserts are molded integrally over steel wear rings and hard-chromed steel gate. The stainless steel stem is a separate element. Any of these elements can be replaced simply and quickly, if necessary, without disturbing the piping hook-up. Seats and gates are interchangeable between 2000 psi and 3000 psi pressure classes. Spare parts storage is simple.

*T. M. Reg. U. S. Pat. Off.

Mudwonder valves are available in 2", 3" and 4" sizes in two pressure ratings: 2,000 psi W.P. (4,000 psi test); 3,000 psi W.P. (6,000 psi test). Also, 5,000 psi W.P. (10,000 psi test) is available in 2" size only.



NO "SANDING UP" . . . Sand simply does not collect in the *Mudwonder*. Large, unrestricted openings into bonnet cavity permit flow of mud to keep bonnet flushed out.

QUICK, POSITIVE SHUT-OFF . . . Gate is moved by a double-thread yoke bushing, which engages stem and bonnet simultaneously . . . gives a 2 to 1 ratio for fast opening and closing. Dual action sealing allows line pressure to help make drop-tight shut-offs. "Bumping" a *Mudwonder* closed—or using a "cheater"—is never necessary.

PROTECTED BONNET THREADS . . . Stem, yoke bushing and bonnet threads are completely lubricated before leaving the factory, and are sealed against dirt, dust and weather.

EASILY AVAILABLE — COMPETITIVELY PRICED . . . See your favorite oil field supply store for complete information, or write Edward Valves, Inc., East Chicago, Indiana, subsidiary of Rockwell Manufacturing Company.

Exploration

ALBERTA

B-A, Pan Am Score Again In Swan Hills Area

The British American-Pan American Sarah Lake 2-13 wildcat, located at LSD 2-13-65-11 W5, has flowed oil to the surface at a rate of 695 bbl per day during a drillstem test in the Swan Hills member of the Beaverhill Lake formation.

The discovery well is situated approximately 110 miles northwest of Edmonton on a 92,160 acre reservation owned jointly and equally by British American Oil and Pan American Petroleum Corporation. Significant oil discoveries have been recently recorded both immediately north and south of the B-A Pan American reservation upon which the Sarah Lake discovery well is located.

In the first drillstem test at the Sarah Lake well the valve was open 2 hours and 45 minutes. Gas reached the surface in 13 minutes: Oil to the surface in 65 minutes. Oil flowed for 100 minutes at an average rate of 695 bbl per day. Gas-oil ratio was 745 to 1. Pipe recovery was 1695 ft of oil and 180 ft of oil-cut mud. Corrected gravity 39.7 deg.

Located in this same reservation, approximately eight miles northeast and 10 miles north northeast of the Sarah Lake discovery are the recent B-A Pan American Beaverhill Lake discoveries at Morse River 2-13, in LSD 2-13-66-10 W5 and A-1 Swan Hills, at LSD. 14-33-66-10 W5.

Union Oil, Hudson's Bay Hit at Eaglesham Test

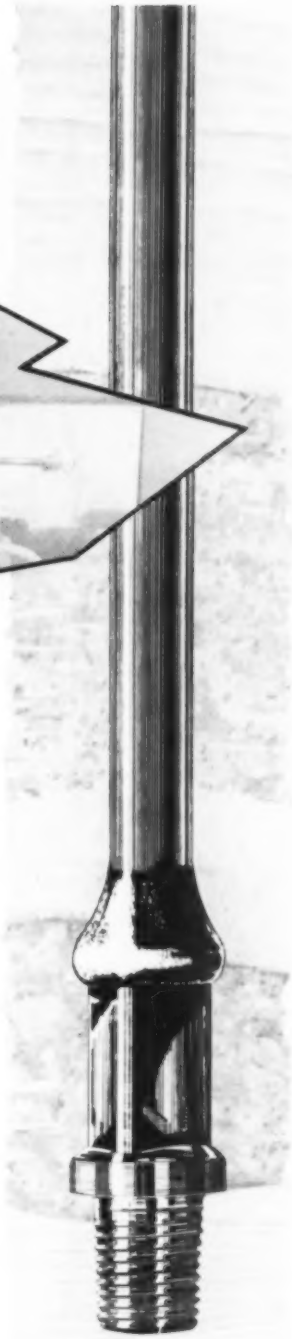
Union Oil Company of California and Hudson's Bay Oil & Gas Company have made an important 1000-bbl-a-day oil discovery in North Alberta, 20 miles from the nearest production.

Eaglesham 10-14, the discovery well, located in the southern part of a 60,000 acre lease block owned jointly by Union and Hudson's Bay Oil & Gas Company, was completed for a flowing potential of more than 1000 bbl a day and is currently flowing 240 bbl a day of clean 38 deg crude oil through a restricted choke with 1325 psi tubing pressure.

Production is from the Normanville reef at a depth of 7605 ft. Nearest production from this reef is about 20 miles to the northeast.

Union and Hudson's Bay had previously drilled a commercial gas well six miles north of the oil discovery, with three shallow Cretaceous gas sands present in this oil well.

From LIBERTY TECHNOLOGY
an excellent NEW product created to reduce the cost of pumping oil



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PUMPING installations for most oil wells should use the time-tested, conventional methods. But for low fluid-volume wells to 5,000 feet in depth, you can save from 10% to 33⅓% with slim hole drilling and completion with the LIBERTY ½-Inch Sucker Rod and LIBERTY Pumping Units.

YOUR NEAREST LIBERTY Field Representative is ready to give technical help in designing installations that can bring YOU these savings. Give him a call, or write LIBERTY. He'll be there when and where you need him.

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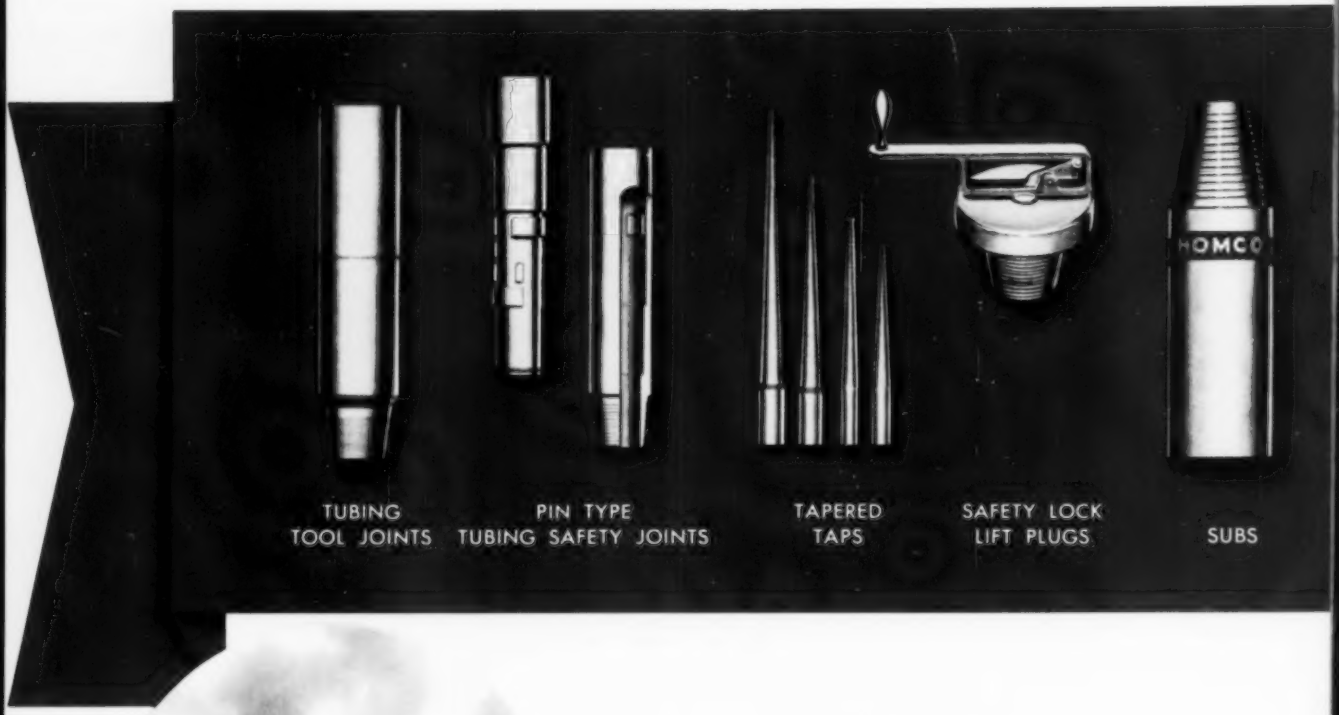

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HOW TO MAKE EXTRA PROFIT WHEN USING BARITE RECOVERY MACHINES

You will be money ahead if you answer these important questions before using any barite recovery machine

How Is Barite Lost?

Most Barite is lost when the tanks are jetted to remove excess solids in the form of fine drilled clays. *If this jetting were not necessary, there would be little need for a barite recovery machine.* When you jet your tanks to get rid of unwanted clays, you also jet out large quantities of valuable barite. The problem is to *selectively* discard unwanted clays and retain costly barites, while processing a minimum volume of mud.

So What Should A Machine Do?

The first and most important requirement is *to reject drilled clays.* Next in importance is the barite recovery efficiency. Virtually no chemicals used in drilling muds can be separated from drilled clays with practical equipment. For that reason, the higher the clay rejection efficiency, the less mud need be processed. As a result, *chemical and barite losses are held to a minimum.*

High clay rejection efficiency is an important reason why the *Clayjector®* is preferred by so many operators. As a matter of fact, it was named Clayjector to dramatize the importance of clay rejection.

What Are Some Other Requirements?

During mud maintenance, the high clay rejection and barite recovery efficiencies shown in the table below are of great importance. Together they result in less barite lost for each pound of clay removed.

Where reserve pits contain important quantities of barite, the Clayjector is outstanding. It has a much higher capacity than other type machines and it delivers *almost completely pure barite. This is an important advantage when very heavy muds are used,* since the clay content of these muds must be closely controlled.

Because of unusually low rental costs, the Clayjector has been proved profitable when as few as 60 sacks of barite per day are required for mud maintenance.

The Clayjector is simple and easy to operate. It is easy to move and it is flexible in operation. All barite is returned as a smooth slurry that is easy to mix. The unit results in faster drilling and greater safety from lost circulation or blowouts because closer control of mud is possible.

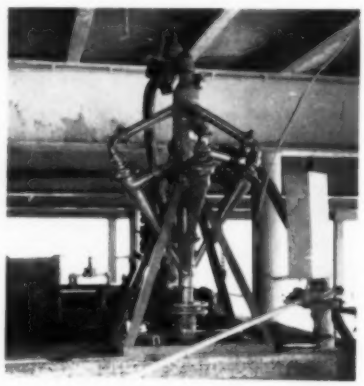
Get the whole story from your SWACO representative or write us direct. If you have been using other barite recovery machines, you will be surprised at the added savings you can make. If you are not using a barite machine, and are using weighted mud of over 11.5 pounds per gallon, you probably can save money by installing a Clayjector.

®Clayjector is trademark of Dorr Oliver, Inc., Stamford, Conn.

FIELD PERFORMANCE DATA ON CLAYJECTORS

	Stream	Weight #/gal	Flow gpm	Bar. Rec. %	% Clay Rejec.
Offshore, La. 15.1 #/gal mud 1 Clone S.G. Bar = 4.18 10/22/58	u.f. o.f.	17.3 8.9	3.3 21.4	95.1	71.1
Offshore, La. 14.8 #/gal mud 2 Clones S.G. Bar = 4.17 11/1/58	u.f. o.f.	17.1 8.9	6.8 40.0	89.7	73.0
Offshore, La. 13.6 #/gal mud 1 Clone S.G. Bar = 4.19 about 11/25/57	u.f. o.f.	16.0 8.8	3.8 21.4	93.8	73.7

U.F. = Underflow — Barite slurry returned to mud system.
O.F. = Overflow — Light solids and fluids to waste.
These results were calculated by an independent testing laboratory from samples taken at the rig.



SWACO

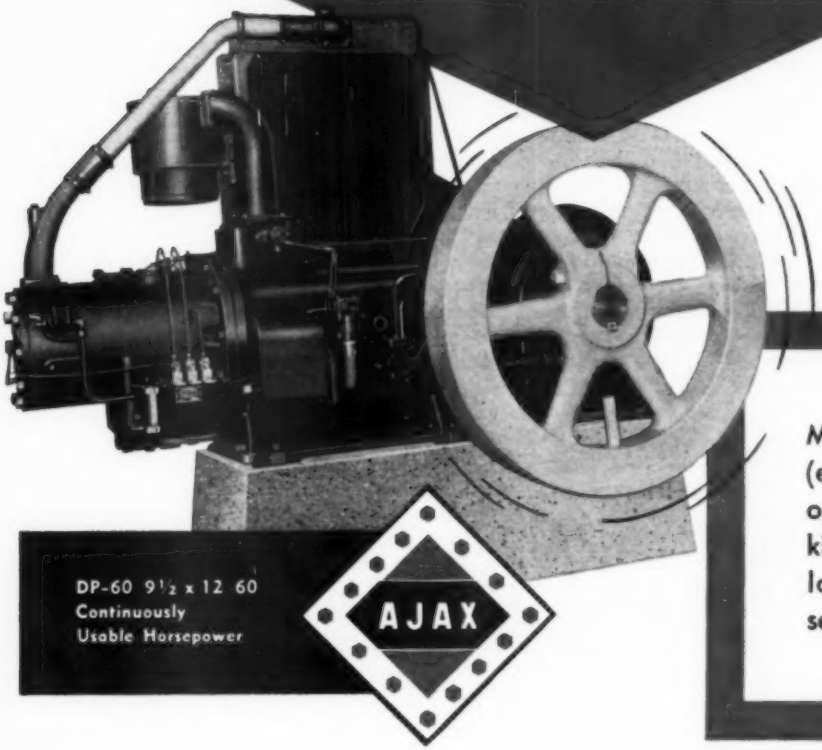
SALT WATER CONTROL Inc.

1809 Continental National Bank Bldg. Phone: ED 2-4434 Ft. Worth 2, Texas

$$* E = \tfrac{1}{2}(m_1 v_1^2 + m_2 v_2^2 + m_3 v_3^2) = \tfrac{1}{2} M_r v_r^2$$

Maximum Horsepower at Minimum Operating Cost

with AJAX ENGINEERED HEAVIER FLYWHEELS



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MORE *long term horsepower per dollar investment.*
REALISTIC *horsepower ratings.*
HORSEPOWER *performance is always higher per dollar invested and your ultimate cost is lower.*
Simple maintenance.

AJAX GAS AND OIL ENGINES

* *Wettenbauer's analysis for flywheel performance*

AJAX also builders of
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Exploration

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70,000 Square Mile Airborne Survey Complete

Approximately $700,000 has been spent to complete one of the most outstanding airborne oil explorations ever undertaken in South America.

The survey has seen an enterprising group of Canadian companies: (1) negotiate in London, The Hague, Havana, New York, Tulsa, Houston, and San Francisco, in a two-week race with time and weather; (2) reconcile competing interests of five major corporations searching for Bolivian oil, by providing each with exclusive information from a combined operation at the lowest competitive price; (3) continue survey flying in restricted curfew periods, while a revolution was attempted and subdued immediately around the survey's base of operations; and (4) produce aerial photography, mosaicing, large-scale mapping, astronomic control and airborne magnetometer results covering some 70,000 square miles of Bolivian jungle and swamp.

Four operating companies directed by Hunting Associates Limited of Toronto — Hunting Airborne Geophysics Ltd., The Photographic Survey Corporation, Kenting Aviation, and Hunting Technical and Exploration Services — co-operated on the multiple job, which began with negotiations in January of last year.

At that time the Canadian Hunting Survey group secured individual contracts with five companies which had been granted exploration concessions by the Bolivian Government — Royal Dutch Shell, Gulf Oil, White Eagle International, California Standard and Tennessee Gas and Transmission.

Each oil company is receiving detailed confidential information on its own concession from the Hunting Survey group. Several companies will exchange general information on the area.

Three Canadian aircraft operated in Bolivia for seven months, based at Santa Cruz; and 100,000 contact prints of aerial photographs were produced at The Photographic Survey Corporation's Toronto laboratories, for delivery to the five clients.

NEW BRUNSWICK

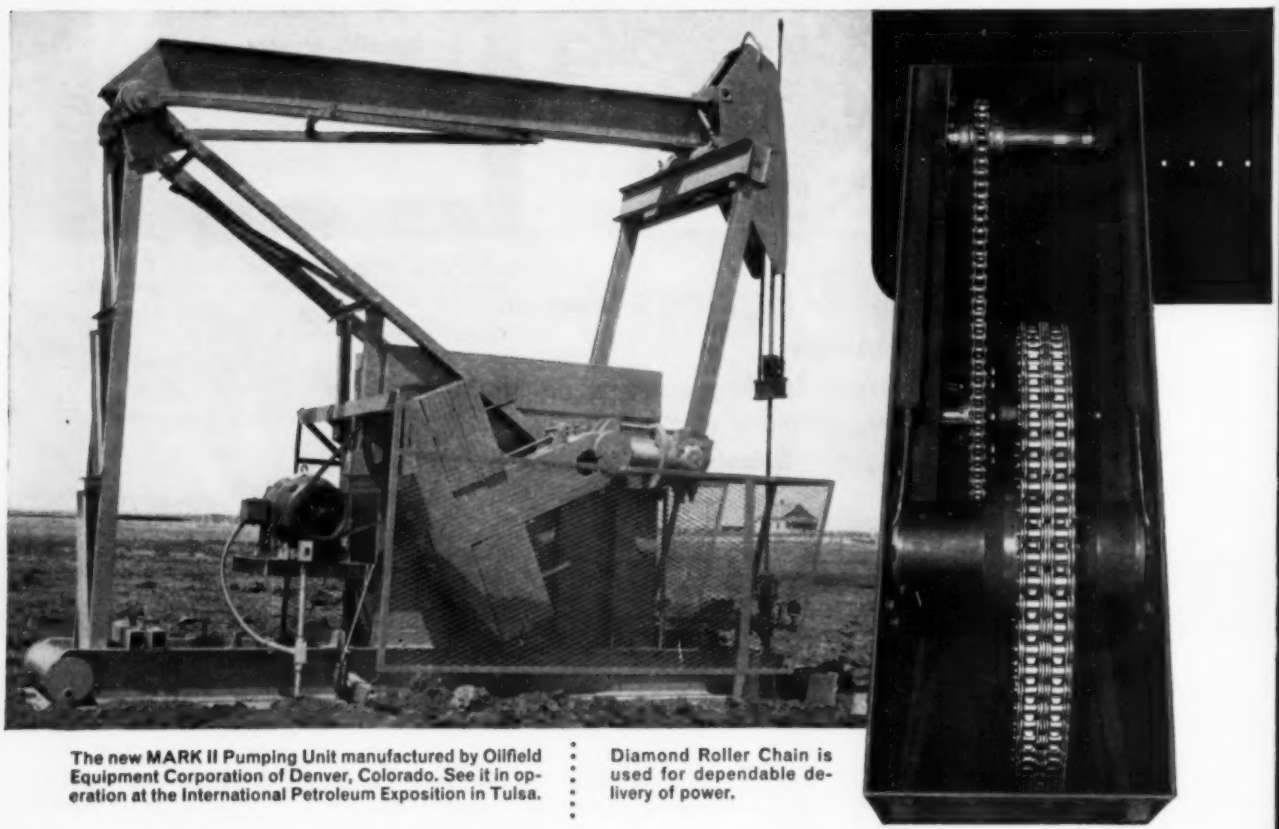
Imperial Plugs One, Begin Second Rank Test

Imperial Oil, Ltd. has announced it had abandoned one exploratory well in New Brunswick and would begin to drill another.

The rotary drilling rig which the company brought to the Maritimes from western Canada will be moved from its first New Brunswick location near the town of Hillsborough to a new site near Berryton, 15 miles west.

The Hillsborough well, which was part of a drilling program carried out in partnership with New Brunswick Oilfields Ltd., was drilled to a depth of 3794 ft before it was abandoned as a dry hole. The rig is now being dismantled, and will be moved by truck to Berryton. Drilling of the new well, to be known as Imperial New Brunswick Oilfields Berryton No. 1, began early in March.

The company is also operating a cable tool rig in New Brunswick. It is now drilling at a depth of 705 ft near St. Josephs. This well, known as Imperial New Brunswick Oilfields St. Josephs No. 1, was begun at the end of January after drilling of the company's first test well in the province, Imperial-New Brunswick Oilfields Gautreau No. 1, was suspended at 2622 ft.



The new MARK II Pumping Unit manufactured by Oilfield Equipment Corporation of Denver, Colorado. See it in operation at the International Petroleum Exposition in Tulsa.

Diamond Roller Chain is used for dependable delivery of power.

GUATEMALA

Ohio Oil Completes Rig-Lift, Begins Wildcat at Chinaja

The Ohio Oil Company of Guatemala's rig airlift is nearing completion. The company's pioneer wildcat well in the interior of this Central American country started about March 15. Essential parts of the rotary rig, tubular goods, drilling mud, cement and other supplies and equipment is now complete.

Ohio Oil of Guatemala is a wholly owned subsidiary of The Ohio Oil Company and is operator for the test on a 109,539-acre unitized block owned by Ohio Oil of Guatemala, Amerada Petroleum Corporation of Guatemala, Continental Oil Company of Guatemala and the Union Oil Company of California. Each company holds 25 percent interest in the acreage. Ohio Oil of Guatemala operates a total acreage of 1.7 million acres.

The airlift will have flown some 6 million lbs of equipment and material into the interior when the well is completed. The destination is at Chinaja, 110 miles from Puerto Barrios on the Caribbean Ocean. The lift started early in January carrying loads of up to 16,000 lbs in three C-82 "Flying Boxcars." Two of the giant cargo planes belong to Ohio Oil of Guatemala and one is leased. After the well starts a C-82 and C-47 aircraft will be used to service the well and crew with additional supplies.

To make the airlift possible, Ohio Oil had to hack a 4000-ft airstrip out of the jungle. The airstrip is some six miles by road from the wellsite, located on the Arruga Grande (Big Wrinkle) Anticline, the structure from which the company hopes to produce oil. After the rig and equipment is flown in it must be trucked to the wellsite over a "switchback" road that climbs some 1000 ft in six miles.

Despite unseasonal rains — average rainfall in the Guatemalan jungle is 200 in. — the airlift has gone much faster than expected. The major difficulty so far encountered is trucking the equipment up the twisting road to the wellsite, an operation slowed considerably by the rains.

To airlift the rig called for many equipment modifications. The drawworks of the big rig are normally broken down to adhere to highway weight limitations. However, the largest portion weighs some 46,000 lbs, nearly three times the capacity of a C-82 aircraft. It had to be further sectionalized to be accommodated in the plane and held to not more than 30 ft long, 7½ ft wide and 8 ft high. Supervising the project is H. D. Hoopman, Ohio Oil of Guatemala operations manager.

Drilling contractor is International Brown Drilling Corporation of California. The rotary rig will be used to drill to a possible depth of 13,000 ft. The rig is fitted with a 142-ft mast, five diesel engines providing 2750-hp, and a wide variety of other equipment and supplies.

NEW ZEALAND

Shell BP, Todd Oil Services Begin Test on North Island

Shell BP and Todd Oil Services Ltd. recently began drilling its first test well near Hawera, in the west coast area of the North Island. The well was inaugurated by New Zealand's Minister of Mines, F. Hackett. A 164-ft derrick, capable of drilling to 12,000 ft is being used. Preparatory survey work for this well has taken three years and cost nearly $3,000,000.

In the east coast area of the North Island, where BP Exploration Company is the operating company for BP Shell and Todd Petroleum Development Ltd., seismic surveys are being carried out and a site for the first test well in the area is being sought.

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. . . a mark of the new MARK II quality

• Like many other leading machinery manufacturers, the Oilfield Equipment Corporation of Colorado specifies DIAMOND Roller Chain for dependable power transmission in its new Mark II Pumping Unit. For greater strength, longer wear, highest efficiency—more and more equipment builders *rely* on DIAMOND. In the oil field—where you can't afford costly downtime—always specify DIAMOND Roller Chain for thoroughly dependable, economical power transmission. Complete stocks at your oilfield store.

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What's doing in DRILLING

Active Rigs Meet Year-Ago Level

For the first time in many months, the number of active rotary rigs in the United States and Canada was up to the level registered a year previous. On March 9, there were 2073 rotary rigs busy in the U. S. and Canada. This compares with a total of 2013 active rigs recorded on March 10, 1958.

Submersible Barge Starts Work in Louisiana

Bay Drilling Corporation, Thibodaux, Louisiana, has christened a new submersible drilling barge known as the "Rome." Ceremonies took place in the Levingston Shipbuilding Company yards at Orange, Texas, where the barge was named in honor of Bay Drilling Company's assistant superintendent, D. J. Rome.

The "Rome" is a slotted-hull type steel submersible drilling barge, with a derrick substructure and superstructure erected above the main deck for the support of the derrick, drilling machinery, pipe racks, and quarters. It is 190 ft long, 50 ft wide, with a 14-ft hull. After christening, the barge headed for its first assignment in Lafourche Parish near Larose, Louisiana.

Airlift to Guatemala Proceeds on Schedule

The job of airlifting over 1,000,000 lb of drilling rig and equipment into the Guatemalan rain forest has gone more quickly than was expected. Three C-82 "flying boxcars" have been carrying the equipment in 15,000-lb loads which are then trucked from the airstrip to the well site.

H. D. Hoopman, manager of operations for The Ohio Oil Company of Guatemala, is expediting the program with personnel of International Brown Drilling Corporation who will drill the exploratory well for Ohio Oil, Amerada Petroleum Company, Continental Oil Company, and the Union Oil Company of California.

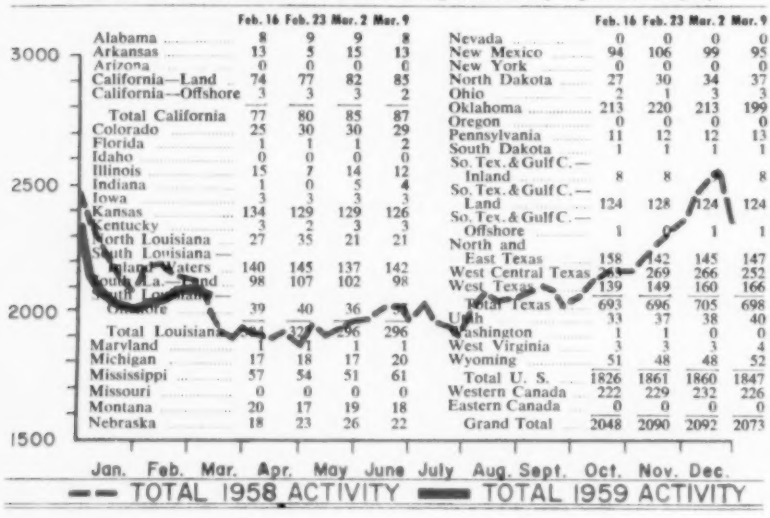
The Dope Bucket . . .

. . . C. W. Sitton, formerly co-owner of D. B. Lesh Drilling Company, Mattoon, Illinois, has sold his interest and has formed the C. W. Sitton Drilling Company with headquarters at Evansville, Indiana . . . R-G Drilling Company, contractors and producers located in Wichita Falls, Texas, has been incorporated under the laws of the State of Texas. All liabilities and operations of the old company have been assumed by R-G Drilling Company, Inc.

Rotary Rigs Operating in Oil Fields of United States and Canada

As reported to American Association of Oilwell Drilling Contractors by Hughes Tool Company.

	Feb. 16	Feb. 23	Mar. 2	Mar. 9
Alabama	8	9	9	8
Arkansas	13	5	15	13
Arizona	0	0	0	0
California—Land	74	77	82	85
California—Offshore	3	3	3	2
Total California	77	80	85	87
Colorado	25	30	30	29
Florida	1	1	1	2
Idaho	0	0	0	0
Illinois	15	7	14	12
Indiana	1	0	5	4
Iowa	3	3	3	3
Kansas	134	129	129	126
Kentucky	3	2	3	3
North Louisiana	27	35	21	21
South Louisiana — Inland Waters	140	145	137	142
South La.—Land	98	107	102	98
South Louisiana — Offshore	39	40	36	36
Total Louisiana	304	327	296	296
Maryland	1	1	1	1
Michigan	17	18	17	20
Mississippi	57	54	51	61
Missouri	0	0	0	0
Montana	20	17	19	18
Nebraska	18	23	26	22
Nevada	0	0	0	0
New Mexico	94	106	99	95
New York	0	0	0	0
North Dakota	27	30	34	37
Ohio	2	1	3	3
Oklahoma	213	220	213	199
Oregon	0	0	0	0
Pennsylvania	11	12	12	13
South Dakota	1	1	1	1
So. Tex. & Gulf C.— Inland	8	8		8
So. Tex. & Gulf C.— Land	124	128	124	124
So. Tex. & Gulf C.— Offshore	1	0	1	1
North and East Texas	158	142	145	147
West Central Texas	269	269	266	252
West Texas	139	149	160	166
Total Texas	693	696	705	698
Utah	33	37	38	40
Washington	1	1	0	0
West Virginia	3	3	3	4
Wyoming	51	48	48	52
Total U. S.	1826	1861	1860	1847
Western Canada	222	229	232	226
Eastern Canada	0	0	0	0
Grand Total	2048	2090	2092	2073



New Firm Incorporated

A new well logging and core analysis firm, Rig Time, Inc., has been incorporated with W. W. Bynum, president, of Shreveport, and Glenn Clark, vice president, of Jackson, Mississippi. Offices are located in the Petroleum Tower Building in Shreveport, and shops and core analysis laboratories will be located in Jackson, Mississippi. New types of logging equipment are in use along with gas analysis instruments using chromatograph principles for gas analysis.

Contractor Announces Personnel Changes

The Big "6" Drilling Company has made a change in its drilling operations personnel. J. H. Almand has accepted a position with the company as drilling superintendent in charge of the three rigs that the company owns and operates. H. "Buddy" Andres who, as vice president in charge of field operations handled the job of drilling superintendent, will continue as vice president and will be in charge of all production.

Deviated Hole Would Cross State Line

If its application is approved, an oil company will drill a hole from one state to be bottomed in another. Application has been made to the Mississippi Oil and Gas Board to drill a well located in Louisiana and to final the hole under a unit in Mississippi.

Jett Drilling Company, Inc., would drill the well in Concordia Parish, Louisiana, and it would be bottomed under a unit on Natchez Island Towhead, Adams County, Mississippi.

To Study Offshore Drilling Structures

Two University of Texas civil engineers, Dr. Lymon C. Reese and Hudson Matlock, have received a $20,870 grant from the university to support their basic research on how movement of different soils affects structures built on land and offshore. They will study fundamental aspects of problems involving the effects of wave action on soil supporting offshore drilling structures and the effects of ground shock wave, pressures, and repeated soil vibrations on foundations.

Humble Plugs Alaskan Wildcat

Humble Oil & Refining Company has plugged the Humble-Shell Oil Company Bear Creek No. 1, Alaskan wildcat spudded on September 23, 1957. Originally projected to 12,000 ft on the Alaskan peninsula near Kanatak, about 350 miles southwest of Anchorage, the test reached a total depth of 14,374 ft without reporting any commercial shows.

A challenge to every drilling contractor . . .

Don't Read This Unless You Want to Save Thousands of Dollars

You have the right to know the facts about slush pump drives . . . is a chain drive better than gear drive?

Let's take weight for example: Because a chain and sprocket is about half the width of a gear of equal torque capacity, and hence is lighter in weight and less costly than a gear. This also reduces the width of the entire pump and further reduces the weight.

And how about shock loads? If the bearings on the pinion shaft and crank shaft are in the outer frame of the pump, the "spring" in the pinion shaft and the crank shaft plus the "stretch" in the chain, will cushion shocks that would break the teeth out of gears. Hence it is more able to withstand shock loads without injury, that would break a gear.

Safety link that's built in: The chain provides a "built-in safety link," like a fuse in an electric circuit, that prevents damage to more expensive parts, and yet has ample capacity to transmit all normal loads within the rating of the pump, with a good factor of safety.

Strength is important, too: In a gear drive only one or two teeth are carrying the entire load (in a helical, or herring-bone gear, it would be a short length of several teeth, approximately equal to two teeth in a spur gear) whereas in a chain and sprocket drive many teeth are sharing the load. In the Wilson Titan Pump a minimum of five teeth in each of the three rows of very large teeth, or a total of fifteen teeth are carrying the load at all times, and these teeth are flame hardened to resist wear. (The wear on teeth that have been running for four years is negligible!)

Do you know about "sliding action"? When the gears run together under load as in a mud pump drive, *a sliding action takes place between the teeth* that might be called a "scouring action." Under heavy load this tends to rub small flakes of metal off the teeth, particularly if there is even the slightest bit of sand or grit in the lubricant. When these metal flakes get in the oil they are carried back again into the gear teeth, where they intensify the wearing process, until it is not long before the gears are completely worn out. And in some pumps this same oil is used to lubricate the bearings, and of course either sand or metal flakes are highly destructive to either plain or anti-friction bearings. In the Wilson Chain Drive Mud Pump *no sliding action, only a rolling action takes place between the sprockets and the chain!* And all oil is filtered.

Main sprocket, crank, and one-piece connecting rods.

Now there's the question of breakage: In a gear driven pump the failure of either of the pinion shaft bearings or either of the crank shaft main bearings will let these shafts separate on that end, and this will throw all of the gear load on the teeth on the opposite side. This will usually cause one or more of the teeth in the gear or pinion to break out, and when these break out they will pile up between the remaining good teeth and create a tremendous force tending to force these shafts apart. This then destroys the pinion (which is usually cut solid from the pinion shaft forging, and is very expensive) as well as the very expensive gear, and often crushes all crank shaft and pinion shaft bearings, and in many cases practically destroys the entire power end.

In a chain driven pump, *the only part that can break is the chain itself.* And if it should break it simply falls down on the large sprocket and does no other injury. And it can be replaced with a new chain at a cost of *less than 10%* of the cost of the gears only in a gear pump; and the damaged links of the old chain can usually be replaced at a cost of 10 to 20% of the cost of a new chain. So the repair cost is only 1 to 2% as much as the repair cost of a gear driven pump!

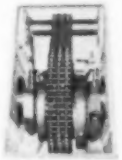
What does downtime cost? If breakage in the power end of a gear driven pump does occur it usually means days or even weeks of "down time" and many thousands of dollars of expense!

If the same thing should happen to a chain drive pump it simply means the replacement of the chain which can be done in the field in about the same time it takes to replace a rod or piston. And the *cost is trivial compared* to gears! (Wilson makes a practice of carrying a spare chain in stock at the nearest parts depot, which is usually within about an hour's drive from your pump).

Compare efficiency losses: A chain drive is much more efficient than a gear drive. In the heavy gears such as used in a mud pump it is usual to use up 5% or more in friction in the gear when the gears are new, and it is not at all unusual to lose 10%, 15% or even more of the available horsepower in friction loss when the gear becomes worn.

In a chain drive pump the loss is only about 2%; and it retains this efficiency over a long period of time.

Reliability points to the chain drive: Various other types of drives have been tried on the other rig drives; the compound, transmission and drum drives, etc. Gears have been tried in the transmission and discarded. No other type of drive has proved its reliability as has the multi strand roller chain. The *gears inside the pump are the only gears in a modern rig drive system.* It stands to reason that if a roller chain is best for all the other drives, it is also best inside the pump!



Wilson revolutionary chain drive means no gears . . . no gear troubles.

To make up your mind take a look at cost per H.P.: What counts is the *cost per horsepower* of actual pump capacity, at the maximum speed it can operate successfully. The average actual cost per horsepower of all twelve larger pumps is $60.10 per H.P. The cost of the Wilson Titan is $40.20 per H.P.; almost exactly two thirds. And the average cost of all fourteen smaller pumps is $66.66 per horsepower, while the cost of the Wilson Giant is $43.50 per horsepower, which is nearly 35% less!

Our customers are reporting savings up to $1500.00 on a 6000-ft. well.

Why not take advantage of these savings yourself? Write or phone for details of our trial pump offer.

John H. Wilson

WILSON MANUFACTURING COMPANY

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WICHITA FALLS, TEXAS

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

"Wildcat Hollow" Gave Name to Drilling Industry

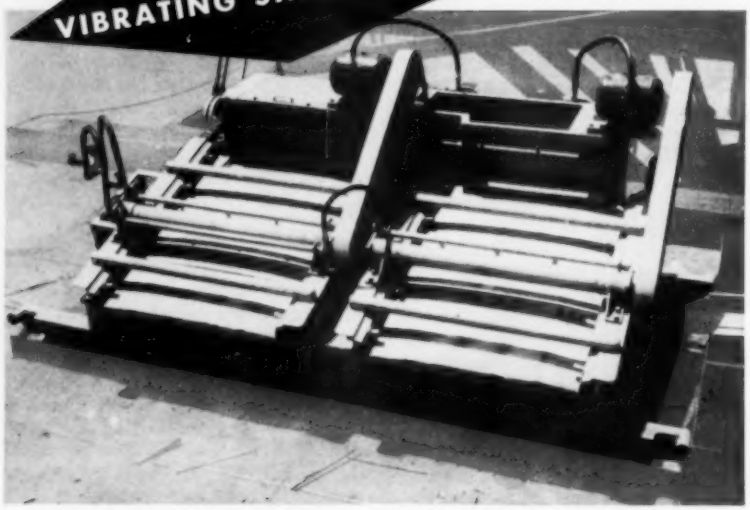
Celebrations of oil's 100th birthday around Titusville, Pennsylvania, will be held in August of this year and will include observance of the term "wildcat," used for a century to denote the performance of a daring, risky, or untried act — usually the drilling of an oil well in an unproven territory.

The word originally described hopeful oil operators who couldn't afford to buy leases in the proven fields around Titusville. So they turned, instead, to the virgin slopes of such out-of-the-way places as Wildcat Hollow. There, according to legend, they fended off wildlife with one hand while they drilled for oil with the other. When one of the "wildcatters" eventually struck oil, the ensuing rush of humanity drove even the wildcats from Wildcat Hollow.

Plans for a gala centennial celebration at Titusville on August 27 include parades, speeches, and sealing of time capsules.

Visitors from all over the world are expected to join in the commemoration of the century-old oil industry which was born when the world's first commercial oil well was drilled near this Western Pennsylvania town on August 27, 1859.

For the VINEGARROON
They Chose a
Thompson
VIBRATING SHALE SHAKER



Thompson . . . Perfect for Offshore Work!

On offshore rigs the reclamation of mud is vitally important and the separation of shale and abrasives from drilling muds means a more effective, time and money saving drilling job. Barnwell Offshore, Inc. chose Thompson for their new offshore rig, the VINEGARROON, because it was field proven, will give them clean mud and make tools last longer, with a minimum of re-tooling and restoration of mud solution.

A Thompson Separator is your surest bet onshore . . offshore . . . for shallow, medium and deep wells. The dependable Sample Machine works simultaneously with the separator, giving a foot-by-foot mud analysis with specimens. Write for Folder.

THOMPSON TOOL CO.
IOWA PARK, TEXAS

SOLD ONLY THROUGH SUPPLY STORES

Visitors to the International Petroleum Exposition in Tulsa, May 14-23, will have a chance to see this amazing rig model, built by Harold Bennett, Twin Disc Clutch Company, Dallas. Bennett, (above) with model, spent 3000 hours of painstaking work to make sure that the model was accurate down to the tiniest bolt.

Built to a scale 1:16, the rig is a marvel of miniature precision. Everything works exactly as on a real rig. The drill pipe is raised and lowered by the drawworks. The rotary table turns the stem. Tiny air clutches engage and disengage with air. Even the mud is real and the mud pumps have removable liners. The drill pipe has standard API tool joints. Below is a close-up of the model rig.

New Mexico Contractor Disposes of Ten Rigs

R. "Cotton" Makin, formerly president of Makin Drilling Company, Hobbs, New Mexico, has disposed of the ten drilling rigs and equipment, and has withdrawn from the contract drilling phase of the oil industry. He now intends to devote his time to management and exploration of oil and gas properties for individuals, groups, or companies.

The ten rigs of Makin Drilling Company had been stacked for about a year.

RUNNING TOUR with MEN in the INDUSTRY

James N. McCoy, petroleum engineer, has joined the staff of Cable & Stephens, Wichita Falls, Texas. He was previously with Gulf Oil Corporation in Texas, Oklahoma, Illinois, and Indiana.

J. N. McCoy

J. S. Bell

John S. Bell, California area manager of Humble Oil & Refining Company, assumed office as 1959 president of the Society of Petroleum Engineers of AIME during the annual meeting in San Francisco, February 15-19. Vice-presidents are **M. Buford Penn,** chief unitization engineer for Sunray Mid-Continent Oil in Tulsa and **Raymond E. Howard,** regional petroleum engineer with Atlantic Refining, Midland, Texas.

Board of directors: **Lewis Finch Jr.,** chief engineer for the production department of Pan American Petroleum, serving a 1-year term; board members beginning 3-year terms are: **L. Preston Wharton,** Atlantic Refining; **John A. Rodgers,** Gulf Oil; **Henry M. Krause Jr.,** Humble Oil & Refining; and **Clifford R. Horn,** Panhandle Eastern Pipe Line.

Dr. Elton Soltes has been promoted from research and design engineer to manager in special projects of Delhi-Taylor Oil Corporation. In his new position, he will supervise the operations of the division and will assist vice president of special projects **J. W. Bartlett** in all activities and assignments as directed. **Herbert V. Wales** has been employed as assistant manager of the land department in the exploration division. He is responsible to **R. L. Caldwell,** manager of the land department.

Jack O. McCall, first vice president of The Louisiana Land and Exploration Company, was elected a director.

Charles H. Dresbach has been named general manager, Bolivian Gulf Oil Company, an affiliate of Gulf Oil Corporation. He succeeds **B. F. Hake** who is returning to the United States for retirement in the near future. **Ben V. Faulkner** was appointed drilling superintendent of the same company.

C. H. Dresbach

B. Oliver Wood

B. Oliver Wood has opened offices as a consulting petroleum engineer at 405 South Allen Street, Monahans, Texas. He has served with C. O. Ice, Monahans, and W. P. Luse, Dallas, for the past 8½ years as a petroleum engineer, supervising a waterflood project on the Luse & Ice leases in the Payton field, Ward County, Texas.

B. J. Rea has been appointed manager of the property purchase department of Jocelyn-Varn Oil Company of Wichita, Kansas and Abilene, Texas. He was formerly Texas division manager of the company. Succeeding Rea is **William Saxon,** formerly manager of the company's land department.

New division managers of Sunray Mid-Continent Oil Company are: Central division, Oklahoma City — **Karl Martin,** exploration, and **C. J. Kerwin,** production. Martin previously was manager of exploration for Sunray Oil Company, a subsidiary firm headquartered in Calgary, Alberta, Canada, and Kerwin was superintendent of the production department's oil division in Tulsa. Southwest division, Midland, Texas — **Fred McDaniel,** exploration, and **V. L. (Fred) Smith,** production. McDaniel presently is assistant superintendent of the oil division in Tulsa and Smith is district production superintendent at Midland.

Gulf Coast division, Houston — **J. H. Gimlin,** exploration, and **M. S. Patton Jr.,** production. Gimlin is now division landman and Patton is manager of the production department's engineering division, both at Tulsa. Rocky Mountain division, Denver — **Thomas A. Clote,** exploration. Clote is presently division geologist with offices in Tulsa. Exploration division managers will report to **H. O. Harder,** senior vice president of exploration, and production division managers will report to **R. E. Foss,** senior vice president of production.

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CEMENT ADDITIVE

FOR OIL WELLS!

ONLY Strata-Crete 6 ® TRADE MARK

GIVES YOU ALL 6 !

This improved perlite cement additive generally ***lowers fill-up cost,*** and is ***easier to place*** (requires only normal pump pressures). ***Superior bridging qualities*** and light weight assure complete fill-ups, and the greater resiliency ***reduces fracturing and shattering.*** Strata-Crete 6 can be used with ***any type or brand of cement*** and in itself is ***not affected by high well temperatures.***

Strata-Crete 6 can be obtained from your oil well cementing service company.

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Who Drills France's Oil Wells?

A look at the financial and organizational structure of the companies leading the progress of petroleum in France

FRANCE EXPECTS to get 20 million tons of oil per year from proved reserves in the Sahara, Equatorial Africa, and the homeland. In a few years French wells will supply all home needs and leave an exportable surplus. The state has been anxious to develop these fields and locate new deposits, through joint ventures and independent drilling companies.

Of France's 20 independent drilling companies, two — the Languedocienne and Forenco — are outstanding, the Languedocienne doing 15 percent of the drilling or 74,000 meters in 1958 and Forenco 12 percent or 60,000 meters. The Languedocienne has branches which add to its total percentage making 19 percent of the French drilling equipment. It has the greatest possibilities also of expansion and is active throughout France and the territories.

The Languedocienne's amortization is well in hand; in this respect its future is more brilliant than that of Forenco, the second in importance. Neither company has yet paid dividends, btu Forenco is a young company which has not acquired its balance.

The Languedocienne was formed in 1955 to put to work the means and material belonging to the National Society of Petroleum of Languedoc Mediterranean. Original capital was enlarged to 3,000 million francs on January 1, 1947: 23.1 percent is held by France; 10.5 percent by various insurance companies, all state-run; 7.4 percent by the Compagnie d'Explorations Petrolières, a geological combine; 4.1 percent by the Bank of Paris and the Low Countries; 2.7 percent by the Worms Bank; and 52.2 percent by various stockholders. Gross profits in 1957 were $5 million (213 million francs) representing 5.3 percent of the turnover. They are entirely due to the main exploitation as the branches have not yet distributed dividends. The stock exchange capital is equal to $20 million (8,400 million francs) and the net yield per share is 1.6 percent.

Branches of the Languedocienne are Interfor (50 percent of the shares held by Languedocienne) and the Italian State Oil Company (AGIP). Three of the six Interfor rigs are working for the Acquitaine Development (Southwest France) and three are going to the South Sahara to work for CREPS.

Another branch is Conservices, created in 1954 with a capital of 230 million francs held 40 percent by Languedocienne, 40 percent by the Slumberger group, and 20 percent by the SN Marep, a French state producer of drilling equipment. The cementing of wells is the specialty and seven rigs are in action at present. Conservices' turnover doubled to $11.9 million (600 million francs) in 1957.

Another branch is Sogefor, divided between Languedocienne and the Societé Générale d'Entreprises, constituted in February 1957. Two rigs which it operates drilled 3270 meters in 10 months last year for Esso Rep. and for CREPS. Other branches are Bonne Espérance, which worked principally for the Prepa Oil Company turning over 950 millions or 50 percent over that of 1956.

The second biggest company in France is Forenco (Compagnie Nouvelle de Forages Pétroliers), capitalized at 2,000 million francs (4.7 million) with 200,000 shares quoted on the Paris Bourse since May 1958. It was formed one year after Languedocienne and has as physical stockholders the Bank of Paris and the Low Countries, the CCF, the Société Auxom, the Compagnie Françaises des Pétroles, and two Moroccan companies, Société Marocaine de Distributions and the Compagnie Générale du Maroc, and various insurance companies. Five new rigs were bought and added to the 11 which the company had in December 1957. The net profit was 58 million francs, ($138,000) a margin of 3 percent, and 60 million francs were distributed in profits.

Other drilling firms include the veteran Forex firm capitalized at $2 millions with eight rigs working now in the South Sahara for the CREPS oil development. This firm drilled the discovery well for Esso at Parentis, France's biggest payoff to date.

SN Marep must also be mentioned, although it is not exclusively a drilling company but a manufacturer and supplier of diesel engines and pipe. The CIPRA Group, which includes Schneider, is capitalized at 1.725 million francs ($4.1 million) doing all the public works of the petroleum industry. Strictly drilling companies are the Cofor, financed by the Bank of Paris and the Low Countries, the Forafrance, using equipment and techniques of the US Brown Drilling Company.

These are some of the companies that are working to enable France to produce all of its own petroleum needs and to become, in just a few years, an exporter of crude oil to the world market.

Running Tour

▸ **Patrick J. Fazio,** formerly assistant vice president and manager of exploration and operations, has been elected vice president and manager of exploration and operations of McCulloch Oil Exploration Company of California. **Paul J. Rigali,** assistant secretary and formerly assistant vice president and manager of the land and lease department, has been elected vice president and manager of the land and lease department. **Louis R. d'Assalenaux IV,** formerly assistant vice president and manager of the administration and coordination department, has been elected vice president and manager of the administration and coordination department. **Denis J. Gleason,** formerly assistant treasurer and controller, has been elected treasurer and controller.

▸ Promotions and transfers of production and engineering department personnel of The British-American Oil Producing Company are: **George W. Murphy** will remain in B-A's Dallas, Texas, headquarters following his promotion from assistant chief engineer of the engineering section to assistant general superintendent of the operations section. Replacing Murphy is **John E. Stein** who formerly was Northwestern district engineer in B-A's Denver, Colorado, production and engineering office. **Earl W. Rogers** was promoted from field superintendent in the company's Marlow, Oklahoma, field to the post vacated by Stein. **Jack Sherrod,** former field engineer in Marlow, replaces Rogers.

Three other promotions in the Northwestern district elevated **John D. Freeman** from field engineer to field superintendent in Sterling, Colorado; **J. D. Horne** from production foreman in Riverton, Wyoming, to field engineer in Sterling; and **Otto Wink** from production foreman in Kimball, Nebraska, to senior production foreman in Riverton.

▸ **John W. Denhollem** of Shreveport, production superintendent and chief production engineer for Arkansas Louisiana Gas Company, has been appointed superintendent of drilling and production in the production and exploration division. **Wyatt H. Thomas** was promoted to chief production engineer and **Frank P. Yarbrough** named production coordinator.

▸ **Albert F. Lager,** resident manager of the Oasis Oil Company of Libya, has been appointed special representative for the parent Ohio Oil Company. Lager is succeeded by **R. E. McMillen,** manager of Ohio Oil's Sidney, Nebraska, production district. Taking McMillen's place in Sidney is **Fredrick C. Aldrich,** supervisor of engineering and contracts in the natural gas division in the general offices.

▸ **W. F. Kieschnick** has been appointed assistant to **W. Dow Hamm,** general manager of foreign and domestic exploration of The Atlantic Refining Company. Kieschnick was previously director of the exploitation section in the firm's research and development department. Succeeding Kieschnick will be **H. F. Dunlap,** formerly director of the research and development exploration section. Moving up to Dunlap's former position will be **S. C. Mut,** previously supervisor of the research and development surface prospecting group.

▸ **L. C. Bonham** has been appointed supervising research geologist in exploration research at California Research Corporation's La Habra laboratory. In his new position Bonham will supervise a broad program of geology.

PATTERNS OF PROGRESS

The Camco Retrievable Valve Mandrel with full open tubing bore, commonly called the standard sidepocket mandrel, is the greatest advancement in the gas lift industry to date. The number and scope of its applications are constantly increasing, particularly in dual and permanent type well completions. Camco offers the industry a complete line of receivers for every well condition in all common casing sizes.

The Camco hydraulically-operated truck with an electronic weight indicator was the first practical unit of this type to service wire line retrievable valves, subsurface controls, sand bailing, wire line fishing, permanent completion operations, tubing perforating, etc. The wire line unit has been adapted to barge and boat use.

Once again, SOMETHING NEW HAS BEEN ADDED . . . See the Camco Exhibit, Booths 198, 199, 200, in the Oklahoma Building, at the Tulsa International Oil Exposition. Write Box 14484, Houston 21, Texas, for literature covering the new products to be exhibited.

TYPE RC FLOW VALVE

TYPE MM MANDREL

CAMCO INCORPORATED

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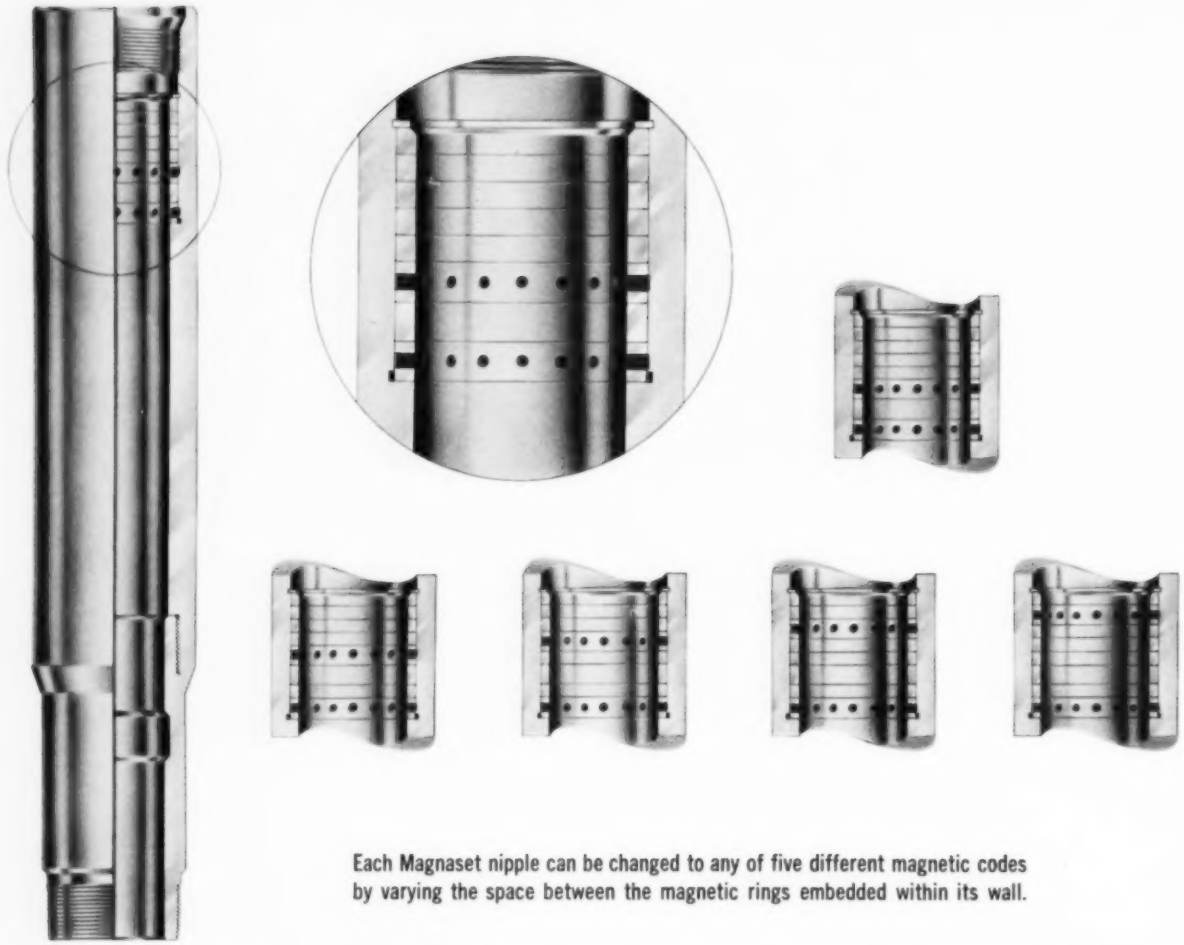


Each Magnaset nipple can be changed to any of five different magnetic codes by varying the space between the magnetic rings embedded within its wall.

Magnaset

FOR SUBSURFACE LATCHES AND PRODUCTION TOOLS – the CAMCO MAGNASET NIPPLE AND SELECTOR TOOL

The electronic principle of Camco's Magnaset Nipple and Selector Tool is the first major advance in wire line, full-open bore nipple and latches in many years. This revolutionary advancement permits the operator to run as many as five full-open nipples in a tubing string and to selectively set the latches with their assorted production tools with an ease never before known.

The upper part of the Magnaset Nipple has two magnetic rings embedded within its wall with a variable space between the rings to form a magnetic code for selectivity. The lower part of the nipple is a full-bore stainless steel tube for packing to seal in and a locking groove to fit the Camco Magnaset Latch. This latch, similar to the Camco "D" and "CE" latches, will carry such tools as storm chokes, tubing plugs, regulators, etc.

When the Magnaset Selector Tool is run in a well carrying a latch, it electronically recognizes the magnetic code at the proper nipple and automatically fires a cartridge. The force of this explosion sets the dogs of the Magnaset Latch and shears pins holding the latch and running tool together, thus leaving the latch securely locked in place.

CAMCO
INCORPORATED

FEATURES:

1 Automatic operation of the Selector Tool when it reaches the magnetic code of the pre-selected nipple causes the latch to lock and shears the running tool loose. No operator skill is required which makes the tool fool-proof for heavy mud, crooked holes and light wireline units.

2 Operator can pre-select and lock in any nipple in the string, regardless of its sequence or position in the tubing.

3 The Magnaset Nipple has a heavy flow coupling as an integral part.

4 The magnetic code of each nipple can be easily changed in the field by changing the space between the magnetic rings.

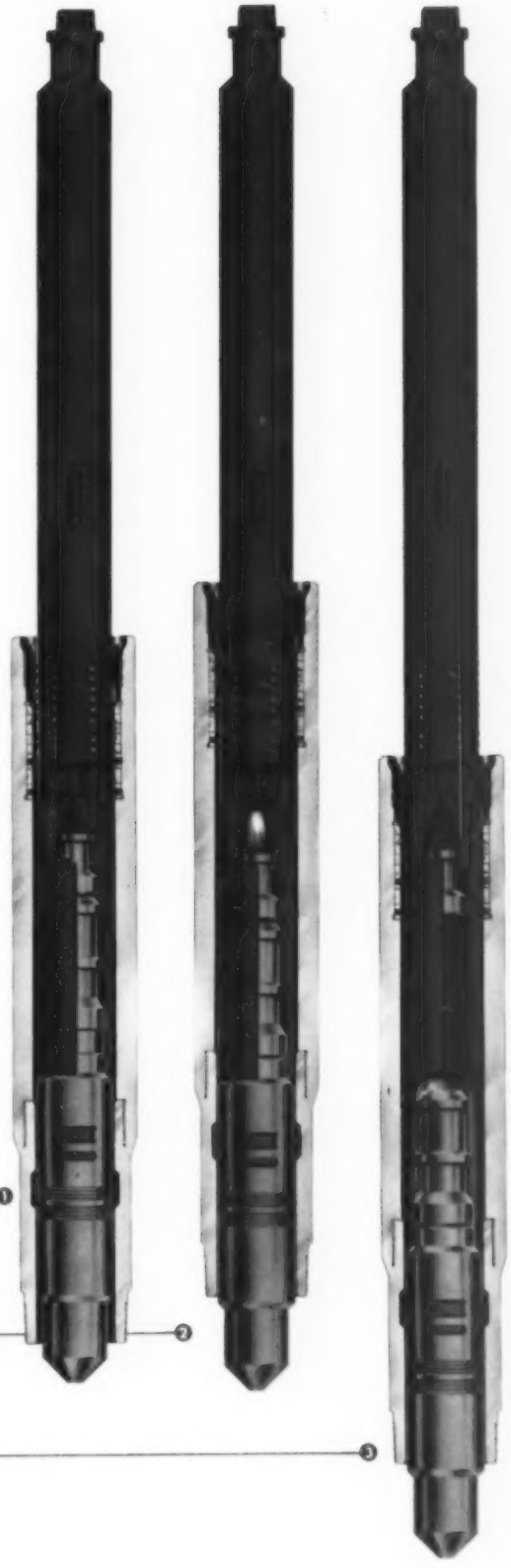
5 One Selector Tool gives selectivity for five magnetic codes or nipples.

6 The magnet rings in the Magnaset Nipples provide an excellent reference point for electronic collar locators.

7 The magnets will not lose their strength for over one hundred years and are unaffected by well temperatures or fluids.

8 Only parts to replace on Magnaset Selector Tool are inexpensive batteries and cartridges.

9 No expensive mechanical keys to wear out and break.



❶ Magnaset Selector Tool, carrying a latch and tubing plug, prior to contact with magnetic code of Magnaset Nipple.

❷ Magnaset twin magnetic field sensing elements respond to the coded magnetic field and automatically fire a cartridge, setting the latch dogs and shearing all pins, thus releasing the running tool from the latch.

❸ The latch is securely locked in place and the selector tool, with pins sheared by the explosion, is withdrawn.

STORM CHOKE

CAMCO TYPE A TUBING
SAFETY VALVE or STORM CHOKE

The Camco Type A Tubing Safety Valve (commonly called a "Storm Choke") is installed in oil or gas wells to automatically shut-in the well tubing and prevent a well from blowing wild should surface controls fail or be damaged. It is a flapper, storm choke with straight-through bore, snap-closing and yet with a hydraulic snubber that prevents closing from pressure surges.

a. The flapper valve is completely out of the cutting action of the flow stream.

b. The hydraulic snubber prevents the valve from accidentally closing from pressure surges in the well.

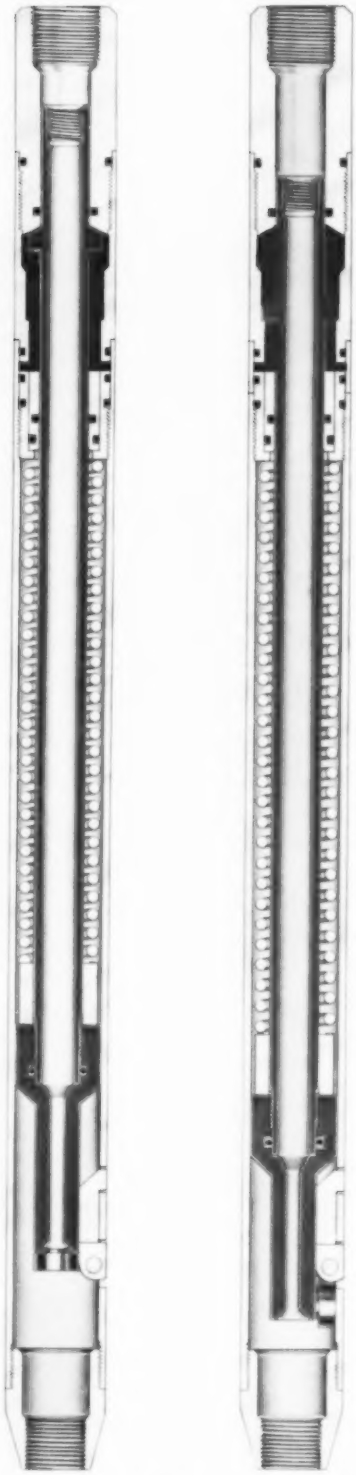
c. The large straight-through flow eliminates sanding up.

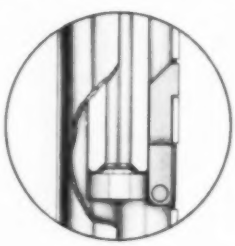
d. There is no turbulence at the bean entrance because of the absence of obstructions or turns in the flow stream.

e. No throttling as pressure drop approaches preset closing differential because of the snap-action closing permitted by the hydraulic snubber design.

f. The hydraulic snubber fluid acts as permanent lubrication reservoir for both O-rings.

g. The valve has all metal seats when the valve closes (the O-ring seals are backed up by a metal seat).





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▸ **Eugene T. Adair** was named president of Texas Pacific Coal and Oil Company. **Hamilton Rogers** was elected executive

E. T. Adair

Hamilton Rogers

vice president by the directors. **H. B. Fuqua,** chairman of the board since 1949 and president since 1954, will continue as chairman and chief executive officer.

▸ **Dr. H. Richard Gault,** professor of geology has been named head of the department of geology at Lehigh University. Dr. Gault succeeds Dr. Bradford Willard who will retire as head of the department June 30.

▸ **M. W. Haas,** director and vice president of The Carter Oil Company, has been granted a temporary leave for 6 months, to serve as assistant coordinator of the producing coordination department, Standard Oil Company (New Jersey) in New York. Haas will replace **N. Y. Ruth** in this position, Ruth having been temporarily transferred to London.

▸ **Lee A. Keeling,** former partner in Keeling and Ford, Tulsa petroleum consulting firm, has reorganized the firm under the name of Lee Keeling and Associates. He was formerly with the Wright Petroleum Laboratories, Magnolia Petroleum Company, and an appraisal and reservoir engineer with Keplinger and Wanenmacher before entering the consulting field in 1957.

▸ **Harry J. Gaston Jr.,** petroleum engineer, formerly with Continental Oil Company, has joined the staff of Robert W. Harrison & Company, consulting petroleum engineers and geologists, Houston, Texas.

▸ **Howard W. Davenport,** vice president and director of Woodley Petroleum Company, was elected a director of Pan American Sulphur Company.

▸ **William J. M. Thompson** has been hired as a publicity agent of the Pennsylvania Grade Crude Oil Association.

▸ **Charles E. Lehecka** has been named chief geologist in Sun Oil Company's Latin American division. **Dr. Richard C. Weart** was named the division's assistant chief geologist. The Latin America division is headquartered in Caracas, Venezuela.

Formerly Lehecka was the division's regional geologist, and Weart was a research geologist.

▸ **Earl Bateman,** independent oil operator, has been elected president of Rimrock Tidelands, Inc. Bateman also serves as a Rimrock director. He is formerly vice president of the Independent Petroleum Association of America and was one of the organizers of the New Orleans Chapter of the American Association of Oil Well Drilling Contractors and the New Orleans Petroleum Club.

Rex L. Shaver was elected to the Rimrock board of directors and will continue in his capacity as executive vice president and treasurer of the company.

▸ **James A. Wallace** has been made chief geologist of the Arabian American Oil Company. He succeeds the late Richard A. Bramkamp. Making his headquarters in Dhahran, Saudi Arabia, Wallace is on loan to Aramco from Socony Mobil Oil Company, Inc.

▸ Promotions and transfers of exploration personnel of Tennessee Gas and Oil Company, a division of Tennessee Gas Transmission Company, were: **Robert C. Honea,** from staff geologist at Houston headquarters to chief geologist in Houston; **Vernon T. Bolleter,** from district geologist at Corpus Christi to district exploration manager at Bellaire, Texas; **R. R. Brillhart,** from district geologist to district exploration manager at Lafayette, Louisiana; **C. S. Algire Jr.,** from geologist at Durango, Colorado, to district geologist at Denver; **Henry C. Dean,** from geologist to district geologist at Bellaire; **James J. Bollich,** from geologist senior to district geologist at Lafayette; **Robert T. Bogan,** from landman at Bellaire to district landman at Denver; **A. G. Hobbs,** from district landman at Calgary, Alberta, Canada, to division properties supervisor for the company's Canadian division at Calgary; **Clyde C. Hamblin,** from landman junior at Oklahoma City to landman at Midland, Texas, and **Gordon Asbury Jr.,** from landman junior at Durango to landman at Wichita, Kansas.

Those transferred include **D. C. Griffith,** district landman, transferred from Wichita to Shreveport, Louisiana; **Gordon G. Geddes,** landman senior, from Midland to Oklahoma City; **Ned H. Tanner,** scout, from Midland to Jackson, Mississippi, and **H. L. Meade,** scout, from Oklahoma City to Midland.

MERLA'S NEW DUAL-USE

FLOW CONTROL VALVE

Type A

For details, Write for Folder No. 258

Use the MERLA Type A for distributing water to injection wells or gas to gas lift wells. This versatile proportioning valve is ideal for either job!

- 2000# W.P.; 4000# Test
- Available in 1" or 2", thru or angle bodies
- ¼", ½", ¾", 1" valve trim
- Stainless steel working parts
- Teflon packing — no lubrication — never leaks
- Calibrated handle for micrometer adjustment
- Easily locked in position

MERLA TOOL CORP

manufacturers of oil tools and gas lift equipment

25

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It's New

Drilling – Producing Equipment

Compressor Plant for Air Drilling

A self-contained, skid-mounted compressor plant, designed for continuous operation on air drilling, has been introduced by Ingersoll-Rand. The compressor, its turbocharged diesel driver, combination cooler, and all auxiliaries are mounted on a 1-piece steel skid. An adjustable regulator on the compressor maintains the desired discharge pressure. In case of malfunction, both compressor and engine automatically shut down before damage can result. *Ingersoll-Rand Company.*

Circle number (1) on reply card.

Multi-Purpose Packer Cups

Devex Engineering Company manufactures a new cup type seal applicable to many field uses. The cups are reinforced against extreme pressure and seal damage

by a series of flat steel springs set in overlapping rows embedded in the seal. Cups are available to fit all standard tools and can be furnished for any special problems. *Devex Engineering Company.*

Circle number (2) on reply card.

High Pressure Dump Valve

Black, Sivalls & Bryson introduces a new high pressure dump valve designed for dumping liquid from pressure vessels. The valve is actuated by a displacement type liquid level controller or other piloting device capable of an air output of 6-30 psi. The valve is available in 1 and 2-in. sizes with either a 3000 or 6000-psi CWP rating. *Black, Sivalls & Bryson, Inc.*

Circle number (3) on reply card.

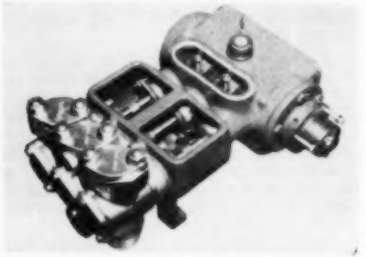
Multiple-String Retrievable Packer

Brown Oil Tools has developed a new hydraulic-set retrievable packer available in a complete line of standard casing sizes for single, dual, triple, or quadruple string completions. In multiple completions, the packers can be set simultaneously or set and tested individually. No wire line manipulation is required in the setting procedure. *Brown Oil Tools, Inc.*

Circle number (4) on reply card.

Plunger Pump for Salt-Water Disposal

Wheatley Pump has announced a new power plunger pump designed specifically for salt-water disposal. The P-175 is a 14-



hp triplex pump with a 1¾-in. stroke. Interchangeable plungers may be used to produce volumes to 936 bbl per day, pressures to 1780 psi. *Wheatley Pump and Valve Manufacturers.*

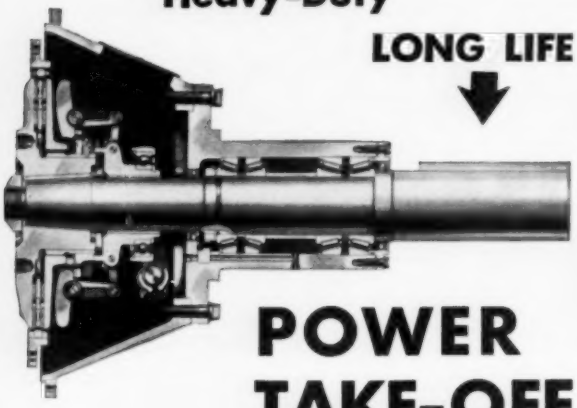
Circle number (5) on reply card.

ROCKFORD

OIL FIELD TYPE

Heavy-Duty

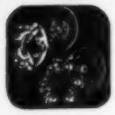
LONG LIFE



POWER TAKE-OFF

➡ Handles 5,000 Pound Belt Loads

This new Oil Field type ROCKFORD POWER TAKE-OFF handles belt loads up to and including 5,000 pounds. Standard commercial sheaves can be used. You can add to the belt-load capacity of *your* equipment by specifying this ROCKFORD Long-Life, extra Heavy-Duty POWER TAKE-OFF.



Small Spring Loaded

Heavy Duty Spring Loaded

Oil or Dry Multiple Disc

Heavy Duty Over Center

Power Take-Offs

Speed Reducers

BW SEND FOR THIS HANDY BULLETIN
Gives dimensions, capacity tables and complete specifications. Suggests typical applications.

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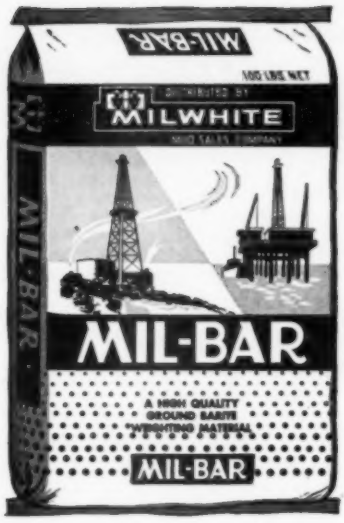
CLUTCHES



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MUD SALES COMPANY

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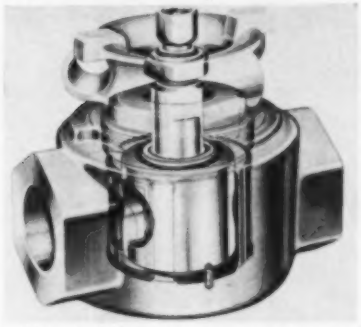
A DIVISION OF MISSISSIPPI RIVER FUEL CORPORATION

Non-Sticking Plug Valves



Hamer Valves has announced a new valve — field tested up to 15,000 psi — which is stronger and lighter than conventional tapered plug valves, needs less turning force, can be overhauled in the lines, and can be used in lubricated or non-lubricated service. The valve has a straight cylindrical seat, with a segmented design, and are designed to function between —40 F and 250 F. They are manufactured in 1 and 2-in. sizes. *Hamer Valves, Inc.*

Circle number (6) on reply card.

Direct Reading Tank Gages

Varec has released 2 new automatic liquid level tank gages, one with vertical reading dial and the other with horizontal reading dial. They are for use on small above or underground tanks, 5 to 15 ft in diam, operating at or near atmospheric pressure. Design features a direct positive linkage between the float and dial indicator. Explosion-proof, hi-low micro switches are available for both gages. *Vapor Recovery Systems Company.*

Circle number (7) on reply card.

All-Purpose Mud Thinner

A new Magcobar product, Spersene, is an all purpose thinner which performs well in any mud system. Its ability to perform well in the presence of common contaminates will simplify thinning problems and eliminate the need for stockpiling a variety of dispersants on locations. It is a chemically modified lignosulfonate and is compatible with normal mud additives and is used in the same manner as other thinners. *Magnet Cove Barium Corporation.*

Circle number (8) on reply card.

Down-Hole Electric Heater

A new oil well heater known as Chromalox forms the bottom end of the tubing string and supplies heat at the sand face to melt paraffin and to lower viscosity of the crude. With a maximum diameter of 3¼ in., the overall heater lengths range from 62 to 149 in. Capacity range is from 5 kw to 20 kw in voltage ratings variable to meet available current supplies. *Edwin L. Wiegand Company.*

Circle number (9) on reply card.

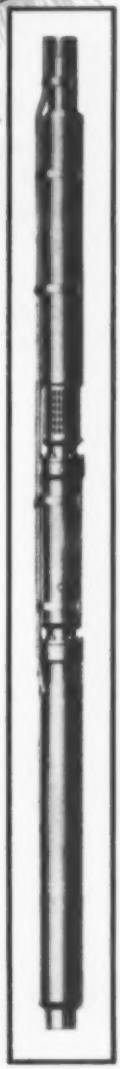
BS&W Monitor LACT System

Fischer & Porter is manufacturing a new BS&W monitor for LACT systems. Capalarm, inferring capacitance alarm, diverts oil for retreating when it is contaminated in excess of specifications. Available in a wide variety of ranges, probes, and time delays, the unit is essentially unaffected by temperature changes. Accuracy is better than 1/10 of 1 percent water content. *Fischer & Porter Company.*

Circle number (10) on reply card.

INCREASE PROFITS WITH

REDA Submergible PUMPS



REDA GIVES YOU THESE COST SAVING FEATURES AND DOES THE JOB BETTER!

- Lower cost for installation, operation and maintenance.
- 250 to 18,000 BPD capacities
- Depths to 10,000 ft.
- Corrosion-resistant construction
- Long life — dependable service
- A complete line to meet pumping requirements

and

INVESTMENT COST IS FAR LOWER WHEN YOU CHOOSE REDA FOR YOUR PUMPING NEEDS.

Write or call for more information. Reda engineers will be pleased to assist and help plan your operations.

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REDA PUMP CO.

BARTLESVILLE, OKLAHOMA

Manufacturers of submergible motors and pumps for over 35 years — for oil, brine and water wells, gasoline and jet fuel —

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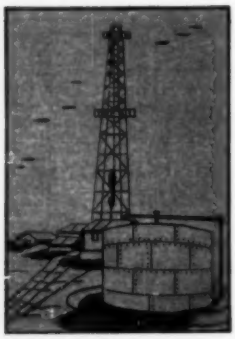
HOW MUCH *PROFIT* IS THERE IN THE OIL INDUSTRY?

In 1958, profits dropped nearly $2,000,000,000 because of *corrosion*, much of it due to *corroded* pipe lines!

SOUTHWESTERN PLASTIC PIPE COMPANY has pioneered in the manufacture of a *full line* of plastic pipe that plugs the profit rat-hole of corroded pipe replacement costs. SOUTHWESTERN has a field staff of skilled, experienced *Application Engineers* to assist you in selecting the *correct* pipe for your job.

FOR RELIABLE, FIELD-PROVEN plastic pipe, ask for SOUTHWESTERN—today's *best buy* for every piping need:



1. Water flooding
2. Salt water disposal
3. High paraffin and sour crude flow lines
4. Tank battery hook-ups
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SOUTHWESTERN plastic piping costs you less, *lasts years longer!* It's pressure-rated, hard and tough with extremely high impact strength.

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SWP-11

New Equipment

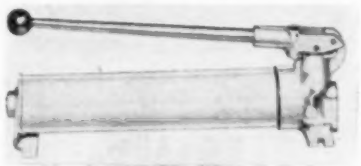
Bottom-Hole Plug for Pressure Build-Up Tests

Otis has a new removable collar lock tubing plug which allows a well to be shut in at, or near, the sand face for pressure build-up tests. The tool suspends the pressure bomb during the test and allows the well to flow uninterrupted while being run in place. The hanger is particularly adaptable to making long-time build-up tests, inasmuch as the wire line unit can be released from the well after the bomb is in place. *Otis Engineering Corporation.*

Circle number (11) on reply card.

Two-Speed Hydraulic Hand Pump

A new manually operated, 2-speed hydraulic pump, which changes speed and pressure automatically, has been announced by Owatonna Tool Company. The pump, designed to perform common pulling jobs, provides a maximum pressure of 10,000 psi at the start of the pull. Then, after the gear, bearing, or liner is broken loose, speed increases and pressure drops automatically. *Owatonna Tool Company.*



Circle number (12) on reply card.

Don't miss The Petroleum Engineer exhibit at the IPE in Tulsa

The best records are made with GEOLOGRAPH RECORDERS!

Yes, GEOLOGRAPH recorders give you the most complete record available while the well is drilling.

This is our "Fifth-of-a-Century" of superior service to the oil industry.

In all ways it always pays to log as you drill with a GEOLOGRAPH recorder, which combines the exclusive unique "Trip Action" and "Magna-Sensor" features.

For information, contact your local GEOLOGRAPH office.

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P. O. Box 1276 • Oklahoma City 1, Okla.

Switch Protects Pumping Units

Protection to pumping units is afforded by a new flow switch developed to act as a flow alarm. Function of the switch is to protect the pump if fluid flow should stop for any reason. It can also be used to shut down the pump if flow becomes excessive. It can indicate a change in flow conditions, activate an alarm, or start a standby pumping unit. *Ball Manufacturing Company, Inc.*

Circle number (13) on reply card.

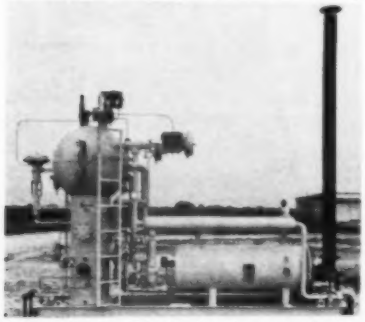
Pump Plungers in New Standardized Lengths

Martin pump plungers are available in new, standardized lengths and threadings. The new lengths of 1½ ft and 2 ft screw together to make additional shoulder to shoulder lengths. They are manufactured with pin on top and box on bottom. Pull tube bushings, box and pin cup extensions, and box and pin repair bushings are companion accessories to the new plungers. *John N. Martin, Manufacturer.*

Circle number (14) on reply card.

Spherical Separator for Distillate Recovery

A new spherical separator, called the R-Tic-Cycle, has been announced by

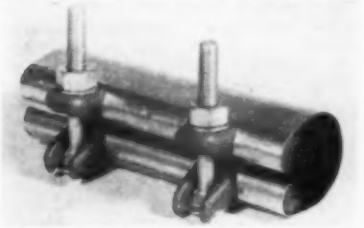


Union Tank. The unit gives maximum distillate recovery under hydrate forming conditions in moderate or cold climates. The unit is skid mounted and completely piped. It requires no indirect line heater, has an integral steam generator, and complete 2-stage separation with independent, steam-fed heating coils in each separator. *Union Tank Division, Butler Manufacturing Company.*

Circle number (15) on reply card.

Band-Type Pipe Repair Clamp

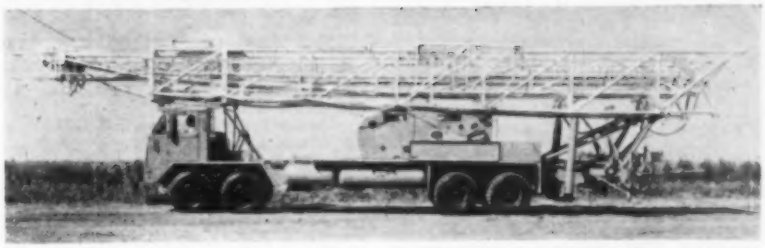
A new, band-type pipe repair clamp developed by Dresser quickly repairs leaks or breaks in steel piping. Installation consists of simply snapping clamp around pipe, dropping bolt head through open-slotted lug, and tightening nut. Compression of large gasket seals the leak completely and permanently. The clamp is



available for pipe sizes ½ in. through 8 in., in 3, 6, 9, and 12-in. lengths. *Dresser Manufacturing Division, one of the Dresser Industries.*

Circle number (16) on reply card.

Well Servicing Unit



A new Franks well servicing unit has been announced. Known as the Explorer, the rig has power up to 400 hp, said to be the most powerful self-propelled servicing and workover rig offered. New engineering features include main drum, water and air-cooled brake system, floating brake drums, faster handling controls. To be introduced at the IPE. *Franks Division of Cabot Shops, Inc.*

Circle number (17) on reply card.

Martin-Decker helps you

GET MORE GOOD FEET PER BIT

by eliminating out of gauge hole

Drillers everywhere are fast finding that one of their best friends is the Martin-Decker Hydro-Mech Torque Gauge. It's easy to see why. The Hydro-Mech quickly and accurately tells the driller when he has an out-of-gauge hole or locked cones. He gets maximum use from every bit, cuts out expensive reaming time *—and gets more good feet per bit.*

The Martin-Decker Hydro-Mech Is An Indispensable Aid For Drilling—Controlled Reaming—Fishing—Milling—and Diamond Coring.

- A rugged instrument of remarkable sensitivity
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- Stabilizes chain and gives it longer life
- Minimizes danger of twist-offs
- Increases footage when drilling with small bits

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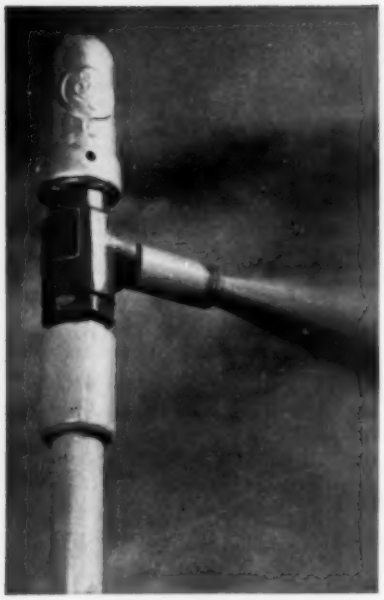
MARTIN-DECKER CORP.

HOME OF THE WEIGHT INDICATOR —— LONG BEACH, CALIFORNIA



WHERE IS THIS DRILLING MUD?

A fraction of a second ago it was part of an overload in a mud line on a drilling rig in Texas. But destructive pressure overloads are no problem when Cameron Shear-Relief Valves like the one above are on the job. That's why this scene could have taken place in any drilling area of the free world. With the Cameron Shear-Relief Valve a common nail (U. S. Standard) takes the punishment instead of expensive pumps, manifolds and other mud line equipment. Fluid contacts the valve's piston, and when desired pressure is exceeded the piston stem shears the nail. It's as simple as that and what's more, you don't have to know if the nail is 60 penny or 16. A handy nail gauge is part of the name plate. Any rig hand can make a correct setting in seconds. When this valve opens it opens all the way. A safety cap holds the clipped nail until another is inserted. If you are making up a mud system, why not COUNT ON CAMERON Shear-Relief Valves for built-in safety and economy—almost everyone does.

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IRON WORKS, Inc.
P. O. Box 1212-Houston, Texas
Export Office: 7912 Empire State Bldg., New York City. In England: Cameron Iron Works Ltd., 76 Grosvenor St., London W. 1, England

New Literature

Bulk Materials and Cargo Handling

Dempster Brothers offers an 8-page brochure which describes the company's "Dempster-Dinosaur," a system of materials handling that employs giant containers up to 40 cu yd and over. As a container is filled, it is picked up by a companion truck, delivered to its destination, and either put down or unloaded. All manipulations of the container are performed from the truck cab by the driver. *Dempster Brothers.*

Circle number (18) on reply card.

Hydraulic Drill Collar

Increased rates of penetration and decreased bit wear in hard formations have been registered by the Grant Fluidrill, a hydraulic drill collar, as reported in a new bulletin. Located between the drill collars and the bit, the equipment is, in effect, a bottom-hole automatic driller maintaining a constant weight on the bit and reducing vibrations in the drill string. *Grant Oil Tool Company.*

Circle number (19) on reply card.

Industrial Engines

A 12-page brochure describing the selection of industrial and automotive engines available in GM Diesel's new all-purpose power line has been released. The booklet gives power ratings and overall dimensions on over 100 in-line, "V" and turbopower engine models. It includes fan-to-flywheel and base-mounted power units to power or re-power practically any type of equipment. *Detroit Diesel Engine Division, General Motors Corporation.*

Circle number (20) on reply card.

Tank Sampling Bobs

A new bulletin describing the Oceco sampling bob has been published. The bob consists of a plastic or brass cylinder with tight-fitting butterfly valves top and bottom. Temperature readings are taken when sampling with the bob, in capacities from 1/5 gal to 2 qt. *Oceco Division, The Johnston & Jennings Company.*

Circle number (21) on reply card.

Polyethylene Pipe

Hercules Powder offers complete specifications and performance data for its Hi-fax pipe in a new report. The publication includes tables and charts giving dimensions and tolerances, tensile strengths, creep characteristics, and stress rupture characteristics of the pipe. *Hercules Powder Company.*

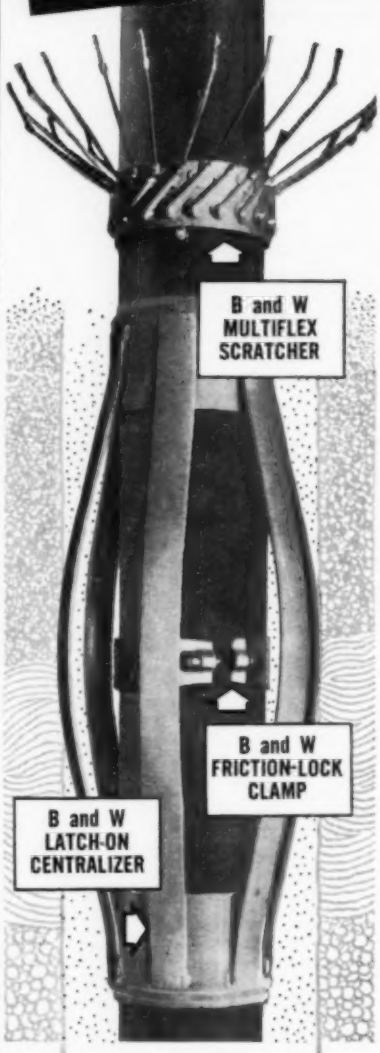
Circle number (22) on reply card.

Automatic Shutoff For Flowing Wells

To shut in and control flowing wells in the event of damage to or breakage of flowlines or surface fittings, Hydril offers a new "inside" blowout preventer and fully automatic control system. The unit consists of a controller, normally positioned at or near the wellhead, and the tubing safety valve installed in the tubing string at any desired point. If flowline pressure exceeds or falls below predetermined limits, the controller automatically operates to close the tubing safety valve. *Hydril Company.*

Circle number (23) on reply card.

B and W
A Good Combination for a GOOD CEMENT JOB



OTHER PRIMARY CEMENTING TOOLS: Hinged Nu-Coil Scratchers • Rotating Scratchers, Multi-Flex and Nu-Coil Types • Automatic Stop Collars • Stabilizers • Rotator Collars • Liner Centralizers.

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123

Power Transmission Bulletin

A new bulletin from T. B. Wood's Sons Company covers the company's complete line of sheaves, variable-pitch sheaves, V-belts, flat-belt pulleys, pillow blocks, flange units, take-up bearings, couplings, and timing-belt drives. Specifications for all products are tabulated in the bulletin. *T. B. Wood's Sons Company.*

Circle number (24) on reply card.

Synchronous Timing Motors

The A. W. Haydon Company has announced a new line of extremely thin synchronous timing motors for 25, 50, or 60 cycle operation in 5 standard voltage ratings. A new bulletin illustrates the motor, contains outline and mounting dimensions, charts, specifications, and completely describes the motors. *The A. W. Haydon Company.*

Circle number (25) on reply card.

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Since 1922

PETROLEUM ENGINEERS
CABLE & STEPHENS
WICHITA FALLS, TEXAS

RESERVOIR ENGINEERING
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Excessive sand and sediment holds back your oil. For fast, easy cleanout with fewer round trips and less downtime, use world famous Miller Sand Pumps.

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SAND PUMP SIZES IN STOCK

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Composite Catalog Page 3400

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General Offices, Box 4516
Oklahoma City 9, Okla.

EXPORT OFFICES
30 Rockefeller Plaza
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Roller Kelly Bushings Described in Bulletin

National roller kelly bushings of new design for square and hexagonal kellys are described in a 4-page bulletin by National Supply. Pictures of the roller assembly and cutaway views show features of design and construction. The bulletin covers sizes 3½, 4¼, 5¼, and 6 in. for both square and hexagonal bushings. *The National Supply Company.*

Circle number (26) on reply card.

Computer Report

Bendix Computer Division has published a 4-page bulletin describing ways in which the G-15 general purpose digital computer is being used in the petroleum industry. Subjects include reservoir studies, geophysical prospecting over water, waterflooding, equipment design, analysis of marketing statistics, and others. *Bendix Computer Division.*

Circle number (27) on reply card.

Level Detection and Control System

Operation of the Level-Tek level detection and control system is described in a 4-page brochure published by Robertshaw-Fulton. The device indicates and controls a predetermined level in liquids, granular solids, or solids of a bulky and massive nature. The instrument has no moving parts within the bin or vessel. *Aeronautical and Instrument Division, Robertshaw-Fulton Controls Company.*

Circle number (28) on reply card.

Retrievable Gas Lift Valves

Otis Engineering has published a new 6-page bulletin on its Type F and FK retrievable gas lift valves. The valves are designed to fit Series M and KB eccentric side-pocket gas lift mandrels, and are run in and retrieved with standard wire line tools. The literature contains full-color illustrations, including cutaway sections of the valves, flow courses, etc. *Otis Engineering Corporation.*

Circle number (29) on reply card.

Selection Guide to Pumping Units

A selection guide for beam and crank counter-weighted pumping units has been prepared by National Supply. The 8-page bulletin features a series of 4 tabular charts of pumping unit data which simplify selection of units to meet any pumping condition. Selection charts include pumping units in 96 specifications and 14 API sizes having structure ratings of 3200 to 32,400 lb. *The National Supply Company.*

Circle number (30) on reply card.

Oil Well Pumping Motors

A new 4-page bulletin describes in pictures, diagrams, and text, the features of new high-slip, high-torque pumping motor with 400 percent starting torque which allows motor to start with counter-weight in any position. Increased slip reduces breaking action required by motor on counter-weights' downward stroke. The motor is rated from 5 to 60 hp. *General Electric Company.*

Circle number (31) on reply card.

HYCALOG DIAMOND CORE BITS

WIRE LINE CORING RECOVERS MORE CORE... FASTER IN GULF AREA

High penetration rates were maintained on these seven wells... *with Hycalog diamond wire line coring bits*... and drill strings didn't have to be pulled for bit changes until coring was completed. Located in Webb, Matagorda, and Orange Counties, Texas, and St. Charles Parish, Louisiana, they are typical of coring jobs throughout the Gulf area.

SIZE BIT	NO. CORES CUT	FEET CUT	% RECOVERY	AVERAGE FT./HR.
7⅝ x 1¾	10	129	100.	7.15
7⅝ x 1¾	12	130	97.	8.25
6¾ x 1¾	5	62	99.9	4.65
7⅝ x 1¾	17	155	80.	5.24
7⅝ x 1¾	37	465	95.5	4.2
7⅝ x 1¾	32	463	87.	6.9

Why not let Hycalog diamond core bits set a record on your next coring program? *And ask us about Hycalog* GAS CHRONO-FRAC *well logging services.*

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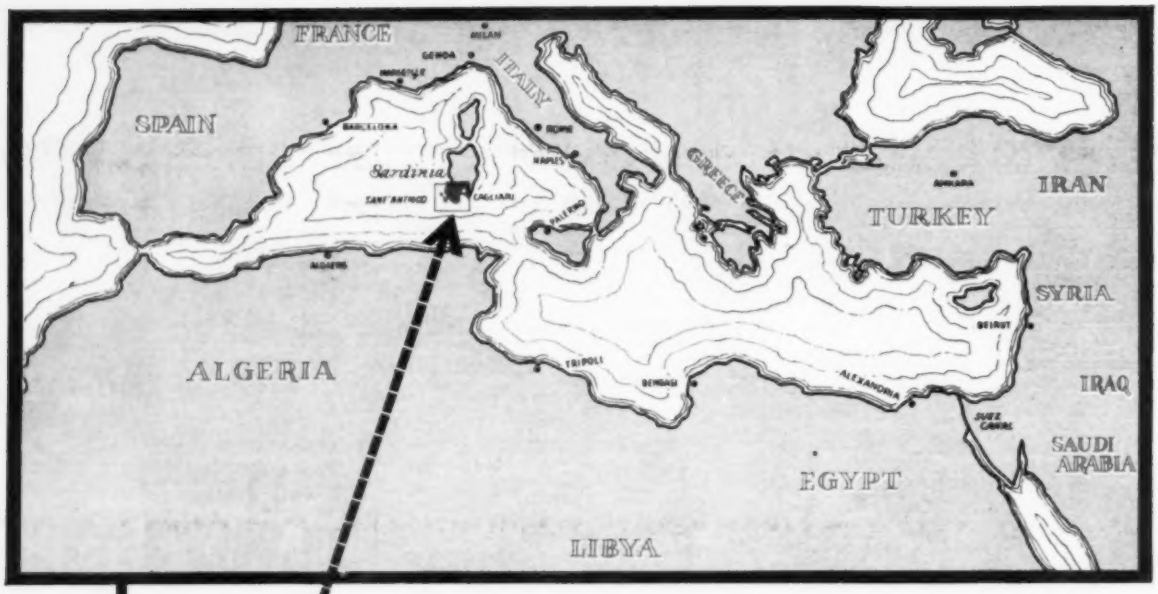
505 AERO DRIVE
SHREVEPORT, LOUISIANA

BRANCH OFFICES IN PRINCIPAL OIL PRODUCING AREAS

DIAMOND BITS — DIAMOND CORING
WELL LOGGING — CORE ANALYSIS



NOW: BAROID products direct from Italy

Baroid-Maffei S.p.A. now supplies the product BAROID* and other mud materials to oil operators in the Mediterranean and Middle East Areas direct from Italy. Baroid-Maffei mines, mills and ships BAROID from Sardinia to these areas. All products are processed under the world-wide quality control standards of Baroid Division.

Write or call Baroid Division, Houston, Texas or Baroid-Maffei, Milan, Italy for full details on products, port agent and maritime references.

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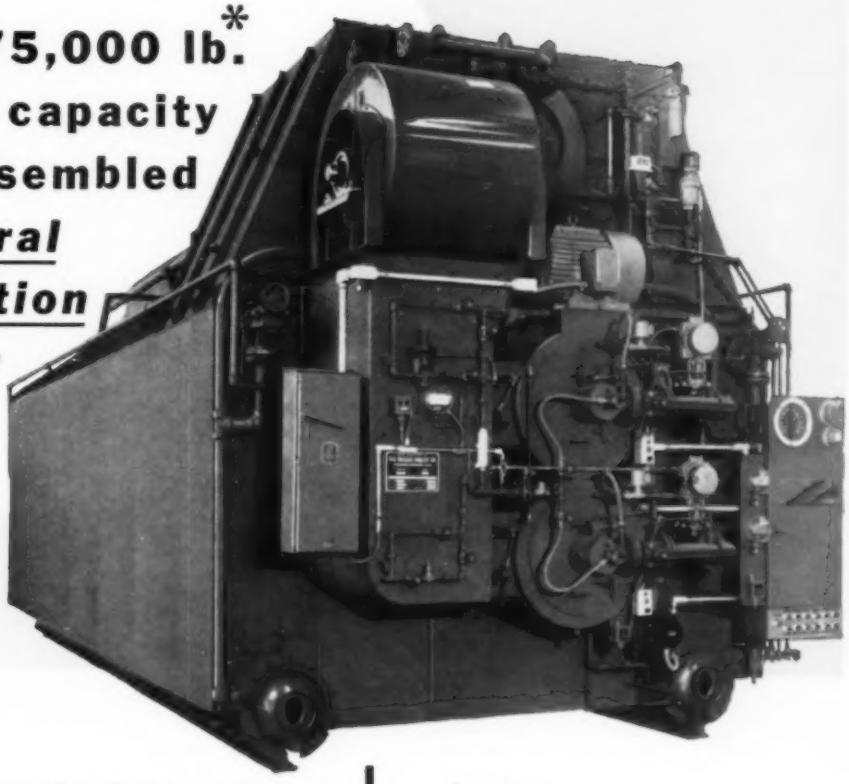
B-138

...now from WICKES

a new 75,000 lb.* per hour capacity shop-assembled *natural circulation boiler*



*75,000 lbs. per hour present capacity.

80,000 lbs. per hour future capacity with economizer

Wickes Type A units are of simple design, ruggedly constructed and adaptable to a variety of operating conditions and may be Oil or Gas Fired.

All units are shipped completely shop-assembled including superheater fuel burning equipment, safety and combustion controls, forced draft fan and drive, soot blowers and feedwater regulator.

Save on

- First Cost
- Operating Expense
- Space
- Delivery Time
- Installation Time

For more detailed information on Wickes Type-A steam boilers, write for our catalog 56-1. Bulletin 55-1 covers the complete line of Wickes Products and Facilities.

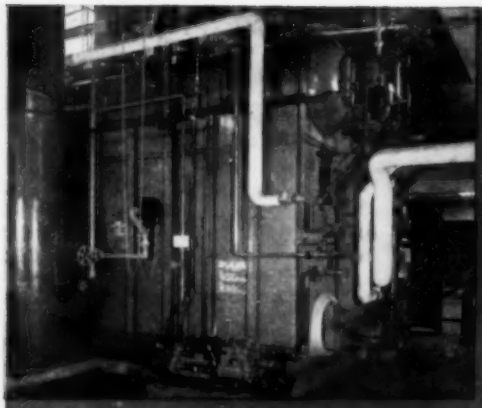
WICKES type A

WICKES

WICKES BOILER CO., SAGINAW 14, MICHIGAN

DIVISION OF THE WICKES CORPORATION

RECOGNIZED QUALITY SINCE 1854 • *SALES OFFICES:* Boston • Chicago • Cleveland • Dallas • Denver • Detroit • Houston • Indianapolis • Los Angeles • Memphis • Milwaukee • New York City • New Orleans • Portland, Ore. • Saginaw • San Francisco • Springfield, Ill. • Tulsa.



A 15,000 lbs/hr unit in a lowboard steel

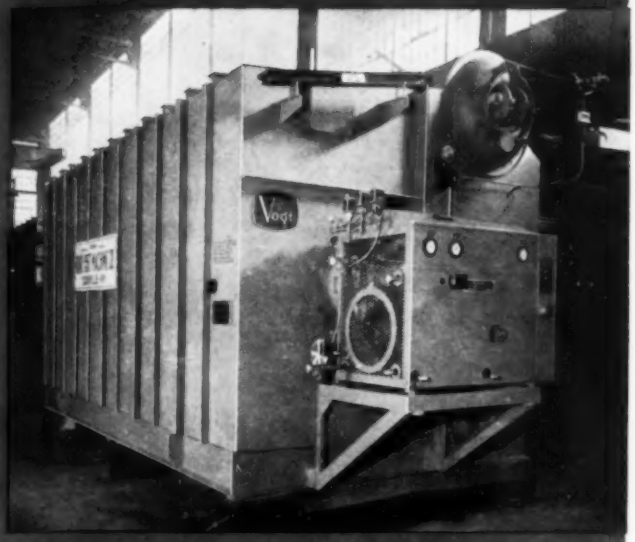
Boilers in various stages of completion in our shop

More Steam per dollar of investment with Vogt

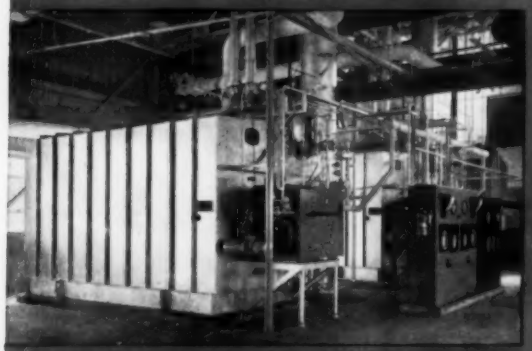
PACKAGE WATER TUBE BOILERS

Completely shop fabricated, with burners, controls and accessories installed before shipment.

Placed on a suitable foundation, only fuel, water, breeching and steam connections need to be made to place unit in operation. Vogt Package boilers are available in oil and/or gas fired types in standard pressures of 175, 250 and 375 pounds per square inch gage.



One of two 30,000 lbs/hr units for a hospital



Two 25,000 lbs/hr units installed in a manufacturing plant

This 18,000 lbs/hr unit is one of two for an office building

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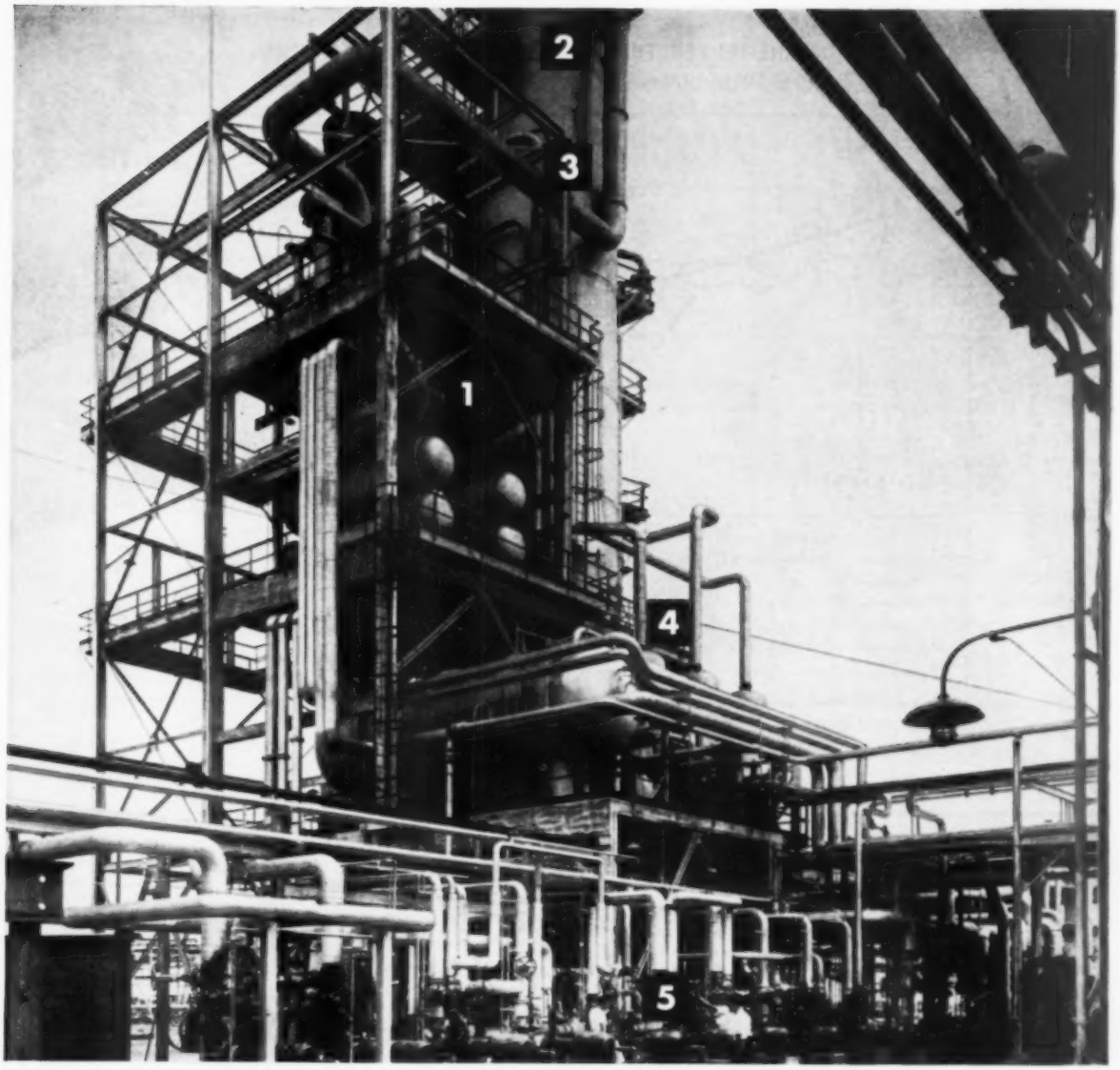

5-point Monel "program" combats corrosion in Creole's 100,000 bbl crude unit

1. Atmospheric overhead condensers – Lukens Monel-clad steel on shell side.

2. Atmospheric tower – 20% Monel-clad on top head and top 11'6" of shell.

3. Atmospheric tower – top 4 trays of Monel alloy.

4. Distillate drum – 20% Monel-clad throughout, nozzles Monel lined.

5. Pumps handling naphtha product and reflux – shafts of "K"* Monel age-hardenable nickel-copper alloy; impeller, lantern and case wearing rings and packing gland of "H"* Monel semi-hard cast alloy; impeller wearing ring of "S"* Monel hard grade cast alloy; Duraseal of Monel alloy.

Creole Petroleum Corporation at Amuay Bay, Venezuela . . . and Foster Wheeler Corporation of New York City . . . took full advantage of the corrosion-resisting properties of Monel* nickel-copper alloys at five trouble-spots to combat corrosion . . . corrosion from dilute mineral acids, by sulfur and naphthenic contents of the feed.

Monel alloy resists corrosion by aqueous solutions of hydrogen sulfide and hydrochloric acid. Chloride traces, which can cause corrosion, and particularly at temperatures below 300°F, can be handled with Monel alloy. This high nickel alloy resists wet carbon dioxide, too.

How can Monel alloy fit in your refinery's program to combat corrosion?

Contact us for help with your corrosion problems. No obligation.

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67 Wall Street New York 5, N.Y.

INCO NICKEL ALLOYS

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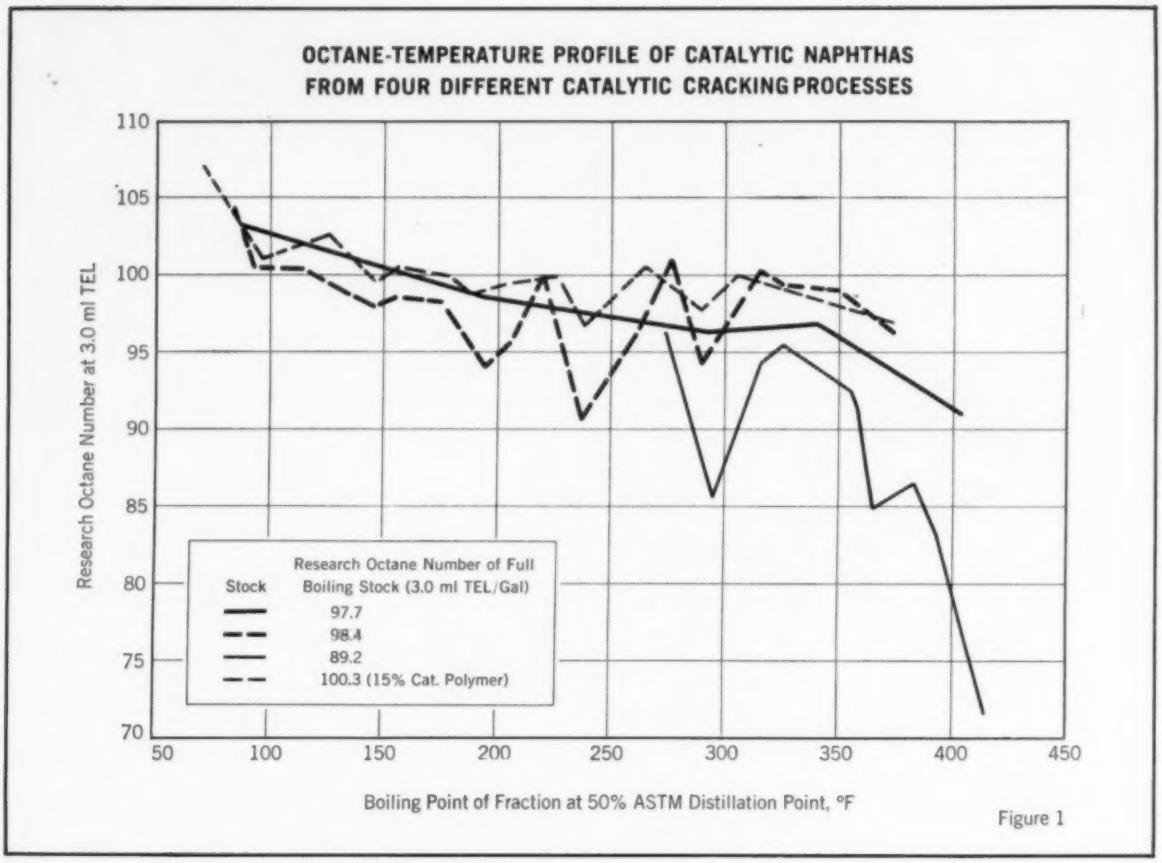


Figure 1

Octane profiles show how to use high-octane gasoline components more effectively

By D. D. Hornbeck, Refinery Technologist

IN RECENT YEARS, refiners have shown interest in separating high (and low) octane hydrocarbons of gasoline blend stocks. Fractional analysis has been u ed to separate, for distribution studies, such stocks as cracked gasoline, reformed gasoline, reformer charge stock and, in some cases, finished gasoline.

A report of several "octane profile" studies conducted in Ethyl's Detroit Laboratories is now available.

How "Octane Profiles" Are Drawn

A sample is carefully fractionated into narrow cuts of 5 to 10 percent of the total fuel. Laboratory octanes, and other pertinent data such as hydrocarbon type are obtained on each fraction. A plot of the distribution of antiknock quality throughout the boiling range of the gasoline is then drawn. This plot is referred to as an "octane profile."

Fractional Analysis For Octane Improvement Studies

In a refinery where tetraethyllead is near the allowable maximum, splitting an existing process stream and blending the higher octane fraction to a given gasoline grade may be an effective approach to octane improvement.

This technique doesn't increase the antiknock quality of the gasoline pool. But frequently it permits the refiner to meet higher octane specifications for a given grade of gasoline.

And higher octanes generally are possible with lower investment and operating costs than by other process methods.

The "octane profiles" of four catalytically cracked gasolines from different refining processes are compared in Figure 1. It will be noted that distribution of high and low-octane hydrocarbons throughout the boiling range of the stock follows a general pattern.

Each stream can be split to yield a portion that is higher in antiknock quality than the full-boiling material. This is true of almost all cracked gasolines even though large differences in octane quality exist at various points in the boiling range.

With the cracked gasolines shown, 30 to 50 percent of the light fraction is from 2 to 4 Research octane numbers higher than the full-boiling material.

Figure 2 compares "octane profiles" of four gasolines from different catalytic reforming processes. In this case the heavy fractions will yield a 20 to 40 percent cut that is 2 to 6 RON higher than the full-boiling material.

Fractional Analysis For Examination of Charge Stock

Figure 3 shows "octane profiles" of two

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

catalytic-reformer charge stocks. The straight run naphtha contains a front-end cut that is already satisfactory blending stock for regular gasoline. Further, the hydrocarbon-type composition showed no naphthenes in this fraction and, therefore, its value as part of reformer feed is questionable.

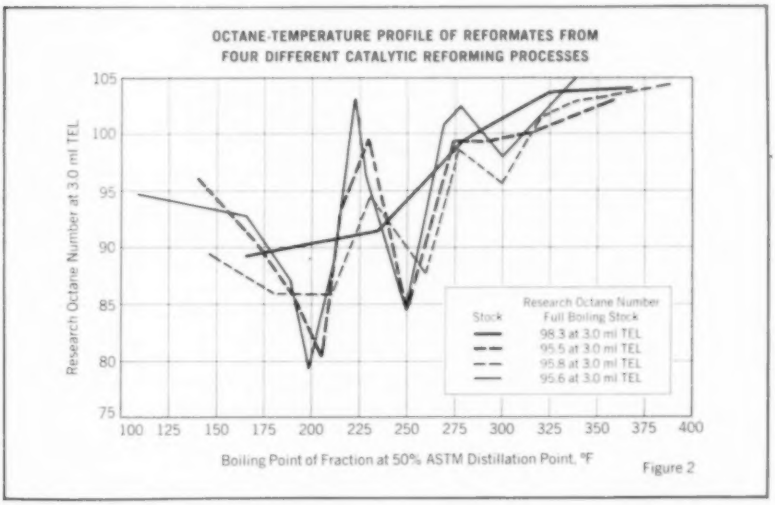
Similarly, the pressure distillate shown in the same figure contains high-octane light olefins according to hydrocarbon-type analysis and "octane profile." This cut could very well be blended directly to motor fuel since, as part of the reformer charge stock, the high-octane olefins would be saturated.

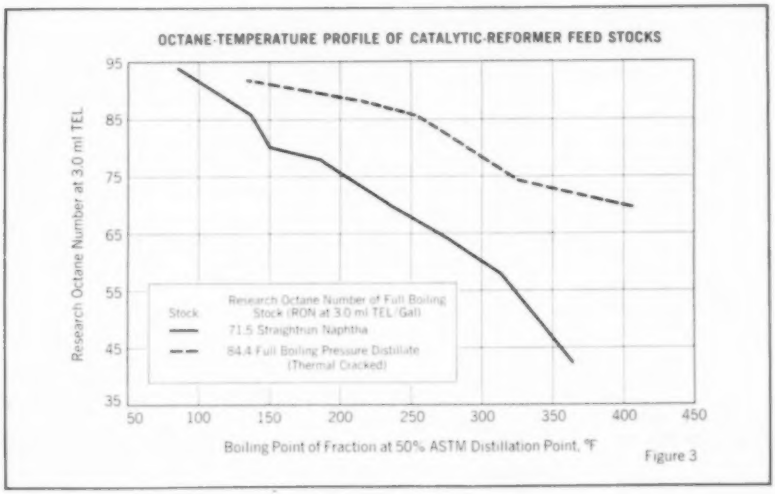
Finding the Cause of Knocking Problems

"Octane profiles" help in understanding some low-speed knocking problems. In engines where the vapor and liquid portions of a fuel are unevenly distributed to the cylinders, TEL may tend to concentrate in the heavier fraction.

Maldistribution usually is most pronounced in the first seconds of wide open throttle accelerations. The problem is aggravated with fuels of low tetraethyllead levels since lighter components may be practically free of antiknock agent upon entering a cylinder during the first moments of acceleration.

With fuels having low-octane front-end components, low-speed road-knock may occur since the front-end octane level may be 5 to 10 numbers below the octane of the whole fuel. The portion of the fuel causing this difficulty can be isolated by fractional analysis. These problems may be solved by replacing the low-boiling, low-octane fraction with higher quality material.


OCTANE-TEMPERATURE PROFILE OF REFORMATES FROM FOUR DIFFERENT CATALYTIC REFORMING PROCESSES
Research Octane Number at 3.0 ml TEL
105
100
95
90
85
80
75
100 125 150 175 200 225 250 275 300 325 350 375 400
Boiling Point of Fraction at 50% ASTM Distillation Point, °F
Stock
Research Octane Number Full Boiling Stock
98.3 at 3.0 ml TEL
95.5 at 3.0 ml TEL
95.8 at 3.0 ml TEL
95.6 at 3.0 ml TEL
Figure 2


OCTANE-TEMPERATURE PROFILE OF CATALYTIC-REFORMER FEED STOCKS
Research Octane Number at 3.0 ml TEL
95
85
75
65
55
45
35
50 100 150 200 250 300 350 400 450
Boiling Point of Fraction at 50% ASTM Distillation Point, °F
Stock
Research Octane Number of Full Boiling Stock (RON at 3.0 ml TEL/Gal)
71.5 Straightrun Naphtha
84.4 Full Boiling Pressure Distillate (Thermal Cracked)
Figure 3

How Ethyl Research is helping you

Ethyl Research is continually utilizing its extensive laboratory fractionating facilities to help refiners in these ways:

1. To develop quality distribution data for octane improvement studies.
2. To evaluate charge stocks.
3. To understand unusual fuel knock problems.

Results of several of these studies can be found in Ethyl's report, "Fractional Analysis of Some Refinery Process Streams."

Copies of the report are available from your Ethyl Representative, or by writing to Ethyl Corporation, 100 Park Avenue, New York 17, New York.

ETHYL CORPORATION
NEW YORK 17, N. Y.

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ANTIKNOCK COMPOUND
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RESEARCH LABORATORIES:
1600 W. Eight Mile Road, Ferndale 20, Mich.
2600 Cajon Road, San Bernardino, Calif.

PETROCHEMICALS

New Petrochemical Process Upgrades Refinery Tail Gases

UOP's new Alkar Process for alkylated aromatics offers diversification and profit . . . using gas streams of low olefin content

C. G. Gerald, G. L. Hervert, and C. B. Linn
Universal Oil Products Company, Des Plains, Illinois

A NEW PETROCHEMICAL PROCESS for the economical manufacture of alkylated aromatics of particularly high purity offers refiners an opportunity to diversify and to make products which are in wide demand in the petrochemical industry. Such diversification of refinery products, apart from the demand for fuels, will stabilize refinery profitability. Principal products are ethylbenzene and cumene. Developed by Universal Oil Products Company, the new Alkar* process uses an entirely new fixed bed catalyst system.

It can employ low olefin content gas streams, which are otherwise only of fuel value, and obtains complete conversion of olefins. It produces petrochemical products of superpurity, and obtains yields of ethylbenzene and of cumene which may be essentially quantitative, both with respect to the olefin and to the benzene. The process employs moderate operating conditions, involves no corrosion problems, and will give profitable operations, even for relatively small units.

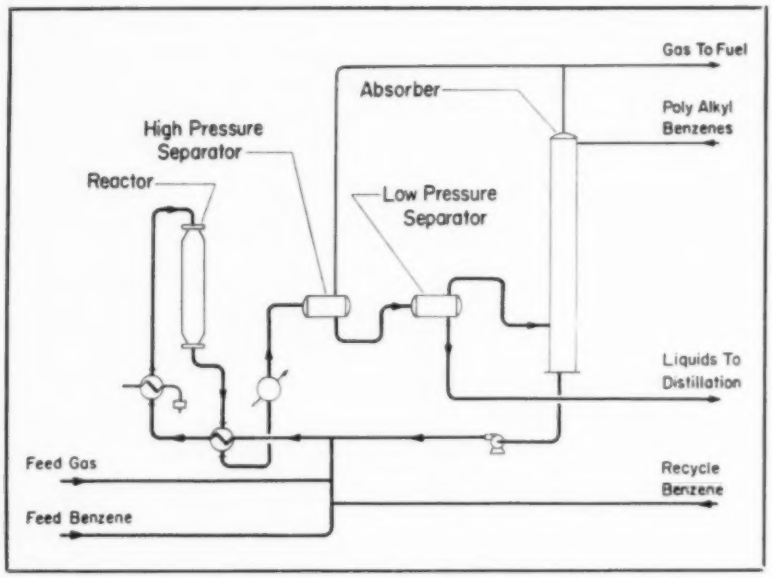


FIG. 1. Alkar process reaction section.

Alkylated aromatics, principally ethylbenzene and cumene, rank high in the list of major petrochemicals. Ethylbenzene, used as an intermediate for styrene manufacture, is currently produced at an estimated rate of 1.3 billion lb per year. Cumene, the raw material for phenol and acetone, is being manufactured at a rate of about 16 million lb per year. Production rates for both are expected to grow at a rapid rate.

The excellent economics of the process, as discussed later, allow petroleum refiners to capture a larger share of the markets for these petrochemicals. The availability of olefins is not limiting in this, since the process can utilize the low concentrations of ethylene and propylene present in gas streams which normally go to fuel.

Considering only the by-product olefins present in the waste gases from catalytic cracking, thermal cracking and coking, there is ethylene adequate for 7.3 billion lb per year of ethylbenzene, and propylene sufficient to produce about 2 billion lb per year of cumene.

Alkar Process Flow

In Fig. 1 and 2, the process flow for an Alkar unit is shown schematically. Feed gas which is normally the deethanizer overhead stream from catalytic cracking or thermal processing is compressed into a gas treating section, not shown in Fig. 1. In this section, certain impurities such as hydrogen sulfide are removed from the gas.

From the treating section, the olefin-containing stream passes to the reactor section (Fig. 1), together with fresh and recycle benzene. After appropriate heat exchange and heating with either steam or hot oil, the benzene and olefin-containing gases pass through the Alkar reactor section.

The products of reaction, which consist of alkylated aromatics, excess benzene and the inert part of the feed gas, leave through heat exchange and cooling into a gas-liquid separator. The separator liquid goes to the fractionation section (Fig. 2). The gases from the separator are sent to fuel after being scrubbed for recovery of benzene vapor.

In the reactor, ethylene and propylene react with benzene, primarily to form ethylbenzene and cumene. However, there is some simultaneous formation of higher alkylated aromatics, such as diethylbenzenes and diisopropylbenzenes. The amount of the polyalkylated products depends upon the ratio of benzene to olefins entering the reactor. The most economical operation of the Alkar process uses a relatively low ratio of benzene to olefin and obtains high yields of the monoalkylated products by recycling the polyalkyls to trans-

*Trademark.

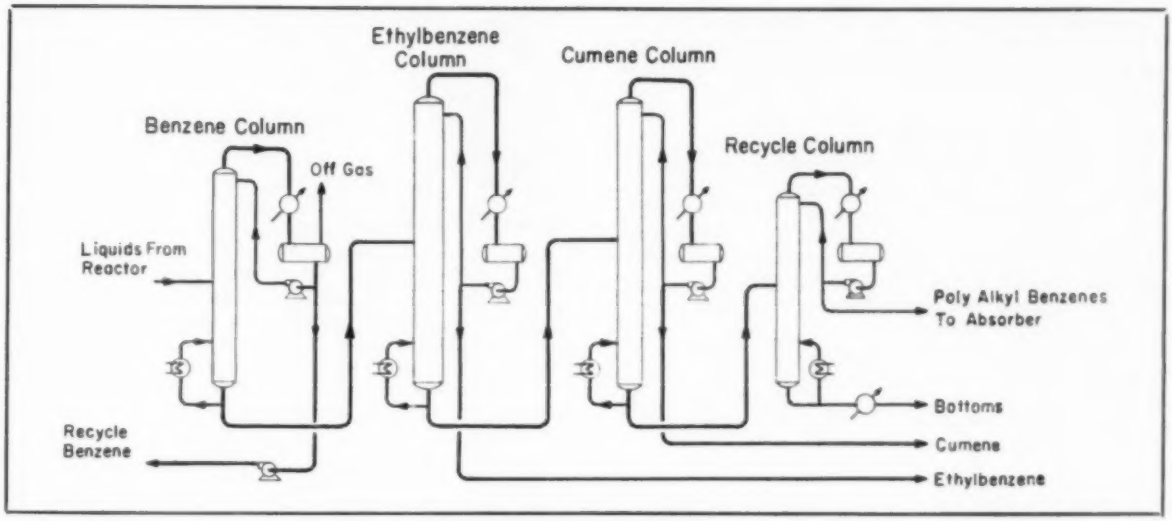


FIG. 2. Alkar process fractionation.

alkylate them with a part of the recycled benzene, forming more ethylbenzene and cumene.

The first column of the fractionation section separates excess benzene for recycle to the reactor. In the second column, super-purity ethylbenzene is recovered as the overhead product. Pure cumene is distilled from the effluent as the overhead from the third column. The bottoms of the cumene column contain the polyalkylated benzenes which are recharged to the reactor. These polyalkyls are also used as absorption oil to recover benzene vapors from the off-gases of the unit. The rich absorption oil is charged directly to the reactor system.

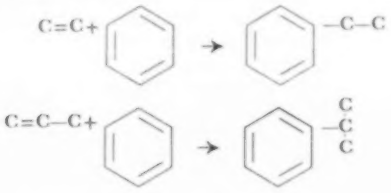
In most Alkar designs, one additional small column is provided to rerun the polyalkyls. This is to remove reaction products derived from small amounts of butylenes or acetylenes that may be present in the feed gases. Butylene will react similarly to ethylene and propylene to form butylbenzenes. With acetylene, two molecules of benzene react with one of acetylene to form 1,1-diphenylethane.

Depending on the amount of non-aromatics present in the feed benzene, a small net stream of recycle benzene may be withdrawn to purge these non-aromatics from the system. The benzene in this purge can be recovered for recharging to the unit, or alternately used as a blending component in premium gasoline.

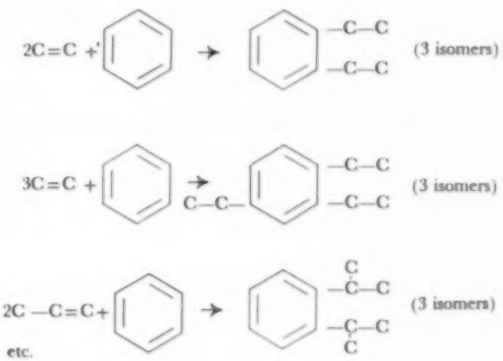
Because the reactions that go on in the process are exothermic and because only moderate temperatures are employed, the heater on combined feed to the reactor is quite small. In some instances, this feed heater is required only for start-up because the heat evolved in going through the reactor is adequate to bring the feed to reaction temperature by exchange alone. The fuel requirements of the unit thus are largely those of the fractionation and gas treating sections.

Alkar Reactions

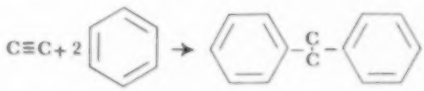
Principal reactions are of olefins with benzene to form monoalkylated aromatics.



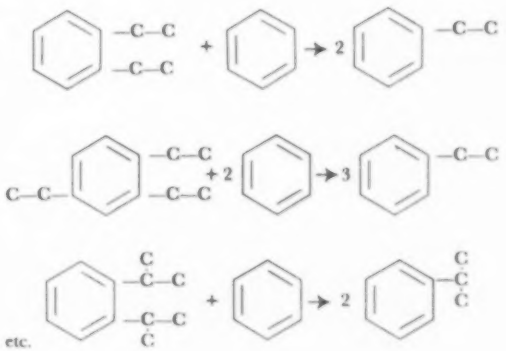
Side reactions which form polyalkyls are:



Reaction with acetylene is:



Transalkylation reactions are:



Reactions in the process are extremely clean cut, as evidenced both by the high purity products as discussed below and by the quantitative accounting for feed reactants in the alkylaromatic products.

Purity of Alkar Products

High sensitivity mass spectrometer analysis to detect impurities in Alkar ethylbenzene demonstrates the product to be of extremely high purity. The sample whose analysis is reported in Table 1 was prepared under full recycle operation with stoichiometric yield. This product was found to contain *far less impurities than API ethylbenzene reference standard!* The reference standard had a 99.95 mol percent minimum purity by freezing point.

Cumene produced in the Alkar operation is likewise of high purity as indicated by the data in Table 2. This sample of cumene was made by feeding a mixture of ethylene and propylene (in a dilute gas stream) to an Alkar unit, so that ethylbenzene and cumene were simultaneously produced.

TABLE 1. Alkar Ethylbenzene Compared with API Reference Standard.

	API Ref. Std. (218z - 25)	*Alkar Product*
C_9 Aromatics	None	None
Paraffins	0.008 to 0.015 mol %	0.003 to 0.008 mol %
Cyclo-Paraffins / Olefins	0.004 to 0.008 mol %	0.002 to 0.006 mol %
Bromine Number (Bromine Index Method)		0.001
Refractive Index at 20°C		1.4957*
Specific Gravity at 60°F		0.8717**

*API Project 44 gives 1.4959, Egloff 1.4960
**API Project 44 gives 0.8718

TABLE 2. Analysis of Cumene Produced by Alkar Process.

Boiling Range	1.0°C
Cumene, % (Infrared Analysis)	100.0
Specific Gravity at 60°F	0.8666*
Bromine Number (Bromine Index Method)	0.005
Refractive Index at 20°C	1.4913**

*API Project 44 gives 0.8664
**API Project 44 gives 1.4916, Egloff 1.4915

Alkar Yields

The yield of ethylbenzene from a low ethylene content gas depends upon whether acetylene and higher olefins are present. Pilot plant operations over extended periods of time have given yields of ethylbenzene of 100 percent, based on both the benzene consumed and the ethylene fed, when ethylene is the only olefin. This high yield has been obtained over a relatively wide range of benzene-to-ethylene ratios.

The ability to get a quantitative yield even at low benzene-to-ethylene ratios demonstrates the outstanding ability of the UOP Alkar process to secure complete transalkylation, even of the most highly alkylated by-products. In these pilot plant runs, full recycle operation was performed; fresh feed benzene and dilute ethylene gas were introduced and only ethylbenzene and inert gas were withdrawn. The composition of all recycle streams and their flow rates reached a steady state.

The conversion of the ethylene and of higher olefins is complete in the process. The ability of the process to give 100 percent reaction of olefins, even when they are present at less than 5 percent in the feed gases, is outstanding in the petrochemical field. Alkar is not limited, however, to low olefin content feed gas, because it also gives complete conversion from 95 percent (commercially pure) ethylene streams. With high purity ethylene feed, the yields are also quantitative and the purity of the ethylbenzene product is equally high. If high purity gases are available, considerable economy in the plant operation results, due to the simplification of the feed gas treating section and of equipment handling tail gas.

Since joining Universal Oil Products Company in 1935 as a research chemist, **Carl B. Linn** has worked chiefly on the Grignard reaction, reactions of sugar acids and hydrocarbons. The inventor of the HF alkylation process, widely used during and since World War II, he holds numerous patents in the petroleum field and has authored technical articles on various projects with which he has worked.

Linn holds membership in the American Chemical Society, American Association for Advancement of Science, and American Institute of Chemists. He took his BS and MS degrees from the University of Nebraska, and his PhD from Stanford University.

C. F. Gerald is a chemical engineer in the Engineering Research and Development Department of Universal Oil Products Company, working primarily in the fields of Unifining, Hydrogenation Processes and Dehydrogenation. He received his BS degree in chemical engineering from Iowa State College in 1936, the MS degree from the University of Cincinnati in 1938 and his PhD degree from Massachusetts Institute of Technology in 1941.

He was affiliated with R. R. Donnelly & Sons Company from 1940 to 1942 and joined Universal Oil Products Company as a research chemical engineer in 1942. From 1947 to 1951 he was Assistant Professor of Chemical Engineering at the University of Washington, rejoining UOP in his present position in 1951. He is a member of the American Chemical Society and the American Institute of Chemical Engineers.

George L. Hervert is a chemical engineer in the refining research section of the Research Division, Universal Oil Products Company, Des Plaines, Illinois. He received his bachelor's degree in chemical engineering from Illinois Institute of Technology.

Since joining Universal in 1936, Hervert has worked in the fields of polymerization, catalytic reforming, alkylation, detergents and catalysis, and has contributed significantly in the development of various refining and petrochemical processes. He holds numerous patents in the field of petroleum technology.

Alkar Economics

Any economic study must recognize that payouts will vary depending on local refinery conditions and on prevailing prices for benzene, ethylbenzene and cumene. In this example we have used the present posted price for nitration-grade benzene of 31 cents per gal. We have significantly discounted the published prices for ethylbenzene and cumene, however, using only 9 cents and 7 cents per lb for these in contrast to 15 to 18 cents and 12 to 14 cents as published. The unreasonableness of the published prices for these alkylated aromatics is obvious since styrene is quoted at 12.6

TABLE 3. Alkar Process Economics.
Charge and Products

Feeds:			
Benzene, BPSD	200		
Ethylene, SCF/SD*	287,000		
Propylene, SCF/SD*	29,000		
Products:			
Ethylbenzene	240	BPSD	24,156,000 lb/yr
Cumene	27	BPSD	2,700,000 lb/yr
Higher Alkyl Aromatics	12	BPSD	
Benzene Purge Stream**	3	BPSD	

*Contained in feed gas from catalytic cracking with 8-12 percent ethylene content, 1-3 percent propylene, traces of other olefins.
**This stream is to remove non-aromatics present in feed benzene.

TABLE 4. Alkar Process Economics.
Investment and Operating Costs
(330 Stream Days Per Year)

Investment:		
Estimated erection cost, battery limits		$1,100,000
Operating Costs: $/CD		
Labor, 1½ men/shift @ $3/hr	$ 108,000	
Supervision and Overhead	108,000	
Laboratory	50,000	
Utilities	153,000	
Chemicals, Catalyst and Misc.	202,000	
Maintenance, 3% of Investment	90,000	
Taxes and Insurance, 2½%/yr	75,000	
Amortization, 10%/yr	301,000	
Interest on Investment, 3% average	90,000	
Total:		$1,177,000
Profitability: $/yr		
Revenues —		
Ethylbenzene @ 9¢/lb	$2,170,000	
Cumene @ 7¢/lb	189,000	
Higher Alkyl Aromatics @ 15¢/gal	25,000	
Total:		$2,384,000
Cost of Manufacture —		
Feed Stocks	$ 860,000	
Operating Costs	430,000	
Total:		$1,290,000
Gross Profit:		1,094,000
Income Tax Allowance (52%)		570,000
Net Profit:		524,000
Depreciation, 10%/yr		110,000
Net Earnings:		$ 634,000
Payout Time	$1,100,000/634,000 = 1.73 years	

cents per lb, and this is manufactured from ethylbenzene. The prices used to value the process products are thought to be reasonable estimates. The ethylene feed to the unit, in a deethanizer overhead gas which would otherwise go to fuel, is charged at fuel value of 15 cents per million Btu.

The profitability of an operation can always be exaggerated by presenting data for a large installation. This process, however, can be employed profitably on a small scale. To demonstrate this, we have chosen deliberately an example of a relatively small installation. Further, the use of only 330 stream days per year for the unit is very conservative.

In Tables 3 and 4, economic data is shown for an Alkar unit producing 279 bbl per std day of products. This size of unit corresponds to the deethanizer gas from a catalytic cracking unit charging from 10,000 to 14,000 bbl per std day.

It is realized that certain items are omitted from Tables 3 and 4, such as additions to off-site facilities and certain cost-of-sales expenditures, which will subtract from the profitability picture shown here. This is done because the magnitude of such costs will vary so widely that no representative figure can be estimated. Another quantity not included is royalties. ★ ★ ★

Brazilian Refinery to be Run from 168-Ft Graphic Panel

What is believed to be the largest control panel ever built in the United States for export was shipped recently from Philadelphia for installation at a Brazilian petroleum refinery.

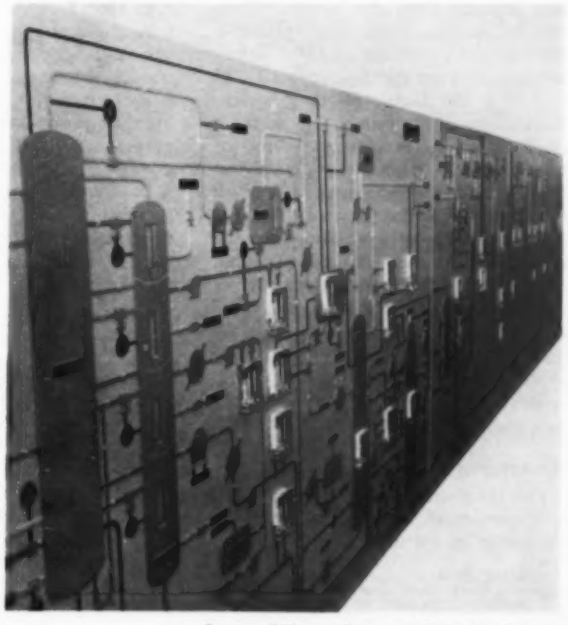
The instrumented 168-ft panel, in 24 sections, will be the control center for new units of the Mataripe refinery which Petreleo Brasileiro (Petrobras) is expanding from 5,000 to 37,000 bbl per day.

Refinery operations are graphically portrayed on the instrumented panel with flow diagrams in color, enabling operators to tell at a glance what is happening at any point in the process at any time.

Instrumentation includes a large number of miniaturized pneumatic indicating, recording and controlling devices, electronic potentiometers, flow meters and special types of valves.

The Mataripe refinery is located 10 miles from the coastal seaport of Salvador in Bahia de Tudos os Santos. The graphic panels, largest of which is 18 ft long, will be barged to the refinery.

Petrobras placed the first units of the Mataripe refinery in operation in 1952. New facilities will include two crude distillation units created by revising existing thermal cracking units; atmospheric and vacuum-distillation units; catalytic cracking, propane deasphalting and phenol solvent extraction units, and lube and wax processing units. Mataripe processes crude oil from Bahia (state of Brazil).



— Courtesy of Minneapolis-Honeywell Regulator Company.

Nuclear Radiation Finds New Horizons in Process Instrumentation

Application of nuclear energy particles for accurate measurement in refinery instrumentation

Edward J. Freeh
Chief Applications Engineer
Industrial Nucleonics Corporation, Houston, Texas

NUCLEAR RADIATION as the primary element of reliable and versatile process variable transducers is rapidly increasing. A large proportion of present applications in the process industries is in level and density measurement. In many instances density is unimportant per se but does correlate with a process variable to be measured. A continuous measurement can be made directly on the process equipment without physical contact with the fluid, which is the greatest single advantage of radiation type measurement over instruments requiring contact with the process fluid. This is a brief introduction to some properties of radiation as well as a non-technical presentation of the principles involved in the use of radiation for the measurement of density. Examples of several applications are included.

Radiation

Three characteristic types of radiation are emitted by radioisotopes, namely Alpha, Beta, and Gamma. Some of the properties of these different emissions are summarized in Table 1. Alpha and Beta radiation is corpuscular or particulate in nature, whereas Gamma radiation is electromagnetic. An Alpha particle is the doubly-charged nucleus of a helium atom. A Beta particle is merely an electron ejected at high velocity from the nucleus of an atom. Electromagnetic radiation is perhaps best described by noting that visible light, heat, and radio waves are all examples of electromagnetic waves. The distinguishing feature is the wave length or energy level. Gamma is extremely short wavelength, high energy radiation.

Penetrating Power

The third column of Table 1 gives an approximate value of the penetrating power of the three types of radiation. The units are given in terms of half-thickness; that is, the thickness of absorber needed to reduce the radiation level to one-half its original value. Values given are approximate; penetrating power varies with the energy level (not intensity) of the radiation. Alpha radiation has a very low penetrating power, being halved by only one-quarter inch of air. Beta, while considerably stronger, still requires one-tenth of an inch of water to halve its intensity. On the other hand, Gamma radiation is very penetrating and is only reduced to one-half its initial value by one inch of steel.

Typical Emitters

Radium is used as a source of Alpha radiation; strontium 90 and krypton 85 are often employed as Beta sources. Radium, cesium 137 and cobalt 60 are commonly used as Gamma emitters. The use of radium is generally confined to small sources because of its relatively high cost. Cobalt 60 has a very penetrating radiation and is used in applications where it is necessary to penetrate a large mass of material. Cesium is preferred over cobalt for intermediate uses partly because of its six-fold greater half-life. The penetrating power of Alpha radiation is too low to permit it to be used in anything except special applications where the source can be separated from the sample material by only a very thin protective film. Beta radiation is selected for applications where the total thickness to be penetrated is quite small; for example, thickness measurements in sheet processes. It is not penetrating enough for direct measurement on normally encountered process piping and equipment. For this type measurement one makes use of the more penetrating Gamma radiation.

Absorption of Radiation

The details of how various types of radiation interact with matter are quite involved. Among other things the amount of radiation that will be transmitted is a function of the type of material, the energy of the incident radiation and the geometry. Nevertheless, as a good approximation, the radiation may be assumed to be absorbed at a rate directly proportional to the amount of radiation present at any given point and to the depth of penetration. This can be expressed mathmetically as

$$-\Delta I = I_o \mu \rho t \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Where $-\Delta I$ is the decrease in intensity of an incident beam of intensity I_o after traversing a thickness Δt of an absorber with a mass absorption coefficient μ and density ρ. If Equation 1 is written in differential form and integrated, one obtains the familiar exponential absorption equation

$$I/I_o = e^{-\mu \rho t} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

a plot of which is given in Fig. 1. For a

TABLE 1. Types of Nuclear Radiation.

DESIGNATION	TYPE	PENETRATING POWER (AS HALF-THICKNESS)	TYPICAL EMITTERS
ALPHA	CORPUSCULAR	1/4 " AIR	Ra
BETA	CORPUSCULAR	1/10" WATER	Sr^{90}, Kr^{85}
GAMMA	ELECTRO-MAGNETIC	1" STEEL	Ra, Cs^{137}, Co^{60}

*Adapted from a paper presented by the author before the meeting of the Western Petroleum Refiners Association in Houston, Texas in January, 1959. Permission of the WPRA to publish this paper is gratefully acknowledged

constant value of I_o, measurement of I is a direct indication of the $\mu\rho t$ product. For a material of constant composition, for example sheets of steel or plastic, the $\mu\rho$ product is constant and hence a variation in I is a direct measure of the variation in thickness t. If on the other hand, one constructs a gage where path length t remains constant, then the instrument output will be a measure of the $\mu\rho$ product. In general, except for materials containing significant quantities of elements of high atomic number, the mass absorption coefficient μ is relatively insensitive to composition, hence the gage output can be calibrated in terms of stream density. If the stream being measured is a binary or a pseudo-binary the gage can still be calibrated in terms of stream density regardless of any variation in μ because there will be a unique density-radiation absorption correlation for this single degree of freedom system.

Radiation Measurement

To use radiation as a means of measuring density one must be able to detect and measure quite accurately the radiation transmitted by the sample material. One of the methods by which this might be done is shown schematically in Fig. 2. The detector is a chamber filled with an inert gas under pressure and containing a probe which is held at a potential above that of the walls of the detector. Radiation that penetrates the sample material enters the detector through a window and bombards the gas in the chamber. Although there are several ways in which Gamma rays interact with matter, the only one of importance here is the ionization of the inert gas in the chamber. Ionization is caused by photons in the radiation beam ejecting electrons from neutral gas atoms to form a positive ion and a free electron. Under the influence of the electric field existing in the detector resulting from the probe being at a higher potential than the wall, the positive ion moves toward the wall and the electron moves toward the probe. Repetition of this process thousands of times per second produces a weak electrical current which flows down through the resistor to ground. The voltage developed across the resistor is proportional to the number of electrons produced by the ionizing radiation, which in turn is proportional to the amount of radiation entering the detector. The output signal is electronically amplified and sent to a read-out device.

Efficiency of a detector in terms of the current output per unit radiation flux input is dependent upon the potential difference between the probe and the shell, or polarizing voltage. The higher the polarizing voltage the greater the efficiency, although not linearly so. With low polarizing voltages many of the free electrons produced by the ionizing radiation recombine with positive ions before reaching the probe. In this region, increasing the polarizing voltage increases the efficiency by reducing recombination losses. Although the specific voltage level is a function of chamber design, in the vicinity of several hundred volts efficiency becomes quite insensitive to polarizing voltage. Since stability in the measuring system demands constant detector efficiency most ionization chambers are operated at voltages corresponding to this efficiency plateau.

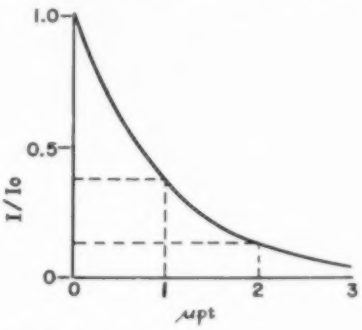


FIG. 1. Radiation absorption.

If the chambers are operated with voltages considerably above the plateau region the electron is accelerated so rapidly that before it reaches the probe it becomes sufficiently energetic to also cause ionization of the inert gas. This process is repeated many times and as a result a large number of electrons are gathered by the probe for a single ionization event. Unfortunately there is no plateau in this region so that very close voltage control is required to maintain detector efficiency constant. In spite of this drawback, Geiger-Mueller tubes find wide application in measurements where high accuracy is not required because the relatively large signal current simplifies the measuring circuitry. One method of improving the accuracy is to use a circuit that counts the number of pulses from the GM tube rather than measuring the total current. Another limitation of GM tubes is that measurement is restricted to low level radiation fields and hence radiation statistics are more of a problem than they are with ionization chambers which can operate in higher radiation fields.

Industrial Applications

A practical embodiment of a radiation source and an ionization chamber for measuring density of process fluids is shown in Fig. 3. The source of Gamma radiation is mounted on one side of the pipe and the radiation detector on the other. Heavy lead shielding is provided to eliminate any personnel hazards. In addition, it protects the gage from stray radiation and from radiation that would be reflected from heavy objects nearby. Radiation passing from the source to the detector is attenuated by the process fluid. As the density of the process fluid increases the amount of radiation entering the detector decreases, and hence the electrical current signal from the detector to the preamplifier is reduced and vice versa. Current output from the detector is therefore a measure of the process fluid density. A permanent calibration is maintained as long as the source – detector – pipe geometry remains rigidly fixed.

Components of a complete measuring system are shown in Fig. 4. The measuring head shown in the lower right hand corner supplies a current signal in the millimicroampere range to the preamplifier. The preamplifier provides power amplification and voltage attenuation of the signal before feeding it to the measuring bridge circuitry in the density instrument housing. All necessary circuit adjustments and periodic standardizations are made with controls provided in the density gage instrument. The output can be used to drive any conventional 5-0-5 millivolt recorder.

Density Measurements for Stream Analysis

In the majority of density measure-

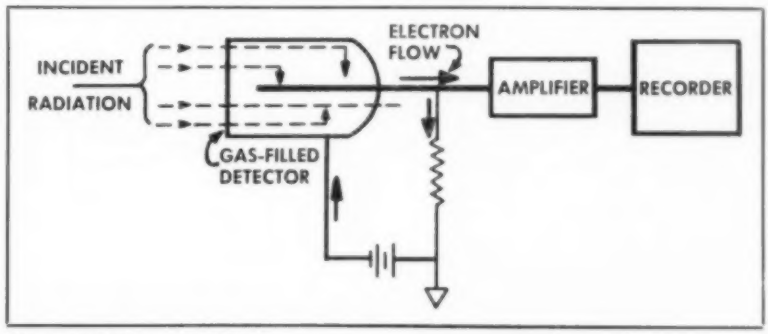


FIG. 2. Radiation measurement.

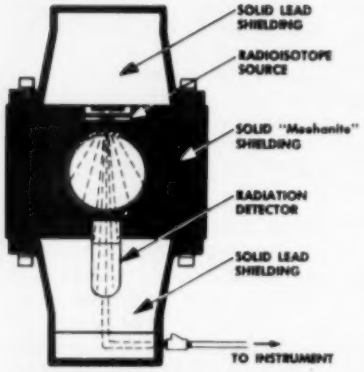


FIG. 3. Cross section of density source-detector unit.

ment applications, not density but some other property such as concentration, percent conversion, etc., is desired. The accuracy with which these properties can be inferred from a density type measurement depends primarily upon the magnitude of the variation of radiation absorption with the desired property. If the variation of μ is small as is generally the case, a measurable gravity change must accompany the smallest change in the parameter it is desired to measure.

An example of a measurement with a very favorable density ratio is the determination of sulfuric acid concentration. In some instances a continuous measurement of sulfuric acid concentration in a process stream is desired but is difficult to obtain with conventional equipment because of problems of corrosion, fouling, sampling, and the like. Measurement of acid strength in sulfuric acid alkylation is a good example. This measurement is readily accomplished with the non-contacting radiation type density gage where the nature of the process fluid is unimportant. The measurement is made directly on the process stream, eliminating any sampling errors.

Percent Solids in a Slurry

A density gage may be used to determine the percent solids in a slurry. The solids represent one component and the slurrying medium the other. If the density of the two components remains constant or varies in a known way with another measurable variable such as temperature, a single density measurement will permit determination of percent solids. If the gravity of slurrying medium varies it is necessary to determine the gravity of the slurrying medium as well as the slurry.

A schematic diagram of one method of measuring percent catalyst in an oil of varying gravity is shown in Fig. 5. The decanted oil is passed through the upper density gage to determine oil gravity. The density gage at the bottom of the settler provides a measurement of the catalyst/oil slurry gravity. By bucking the two signals in a computing bridge the effect of oil density variations can be eliminated to give an output proportional to percent catalyst. In the diagram the output signal is being used to control the percent catalyst in the slurry.

Percent Flash

The density of a vapor/liquid system varies with the relative amounts of each phase present. In a flashing operation where a superheated liquid is partially vaporized, a density gage can be used to determine the percent flash from a mixture density measurement. Fig. 6 shows a density gage being used in a system to control the percent flash in the furnace effluent. Small variations in crude gravity will have a minor effect on percent flash measurement because of the great difference in gravity between the vapor and liquid. If crude variations are large, a second gage can be used to measure the density of the unflashed material and the signals combined in a manner similar to that used in measuring percent catalyst suspended in a variable gravity oil. If circumstances preclude holding percent flash constant, the information can be used for feed-forward control to adjust column conditions.

Other Applications

There are many other applications where radiation absorption techniques may be used to good advantage. In some cases it represents the only presently available method of making the measurement. This list summarizes the

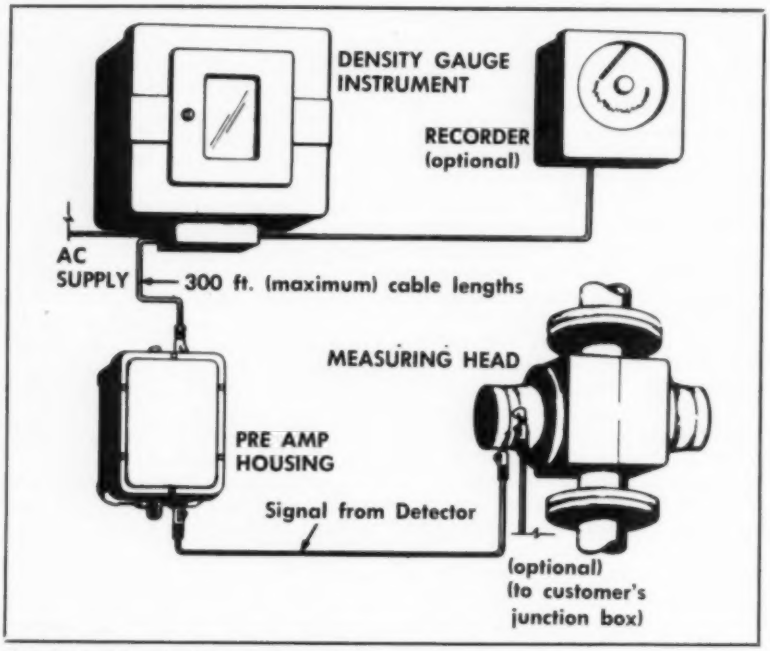


FIG. 4. Complete density measuring system.

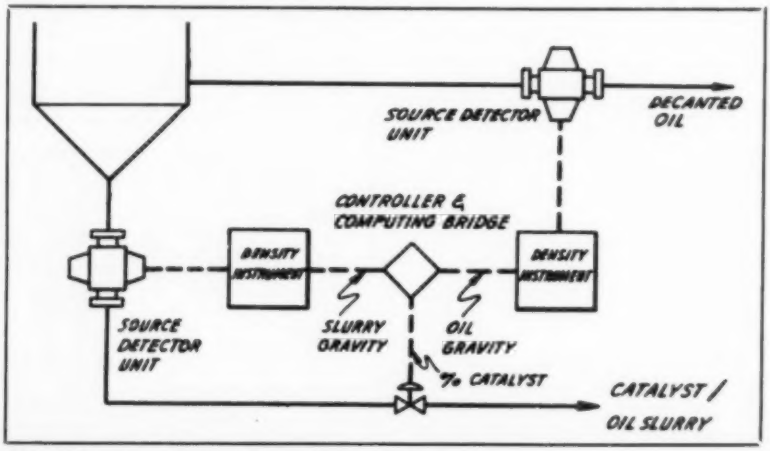


FIG. 5. Percent solids — variable gravity liquid phase.

more common measurements:

1. Composition of binaries and pseudo-binaries,
2. Percent solids in a slurry,
3. Vapor/liquid ratio,
4. Interface detection (pipelines and process equipment),
5. Chromatograph detector,
6. Chemical reaction monitoring,
7. Empirical correlations (e.g., viscosity, asphalt penetration).

Measurement of Level

The applications discussed so far all require a very accurate measurement of the amount of radiation absorbed by the process fluid in order to infer some intrinsic property of the fluid. An equally important use for radiation gaging in refinery operations is the detection and measurement of level, an extrinsic property independent of the specific substance. In level applications the source and detector are mounted so as to detect the position of an interface between two phases of different density. In most level applications the density difference between the two phases is large, for example, air and water, hence, level applications do not normally require the precision radiation measurements required in density determinations. For this reason detection is generally accomplished with GM tubes in lieu of the more expensive ion chamber. Although there are a great many ways in which sources and detectors can be mounted on a vessel to provide an indication of level or other conditions existing therein, the majority of level applications can be classified as either fixed point or continuous measurements. A fixed point measurement provides yes-no information on whether a level is above or below a given point. Such a measurement is usually used to provide either a high or a low level alarm signal, or for on-off control. The continuous level measuring system provides information on the position of an interface in the vicinity of the source detector unit.

Edward J. Freeh *is chief applications engineer of Industrial Nucleonics Corporation's Petroleum Division.*

He is a registered petroleum engineer and holds a bachelor's, master's, and doctor's degree in chemical engineering from the University of Dayton (1948), Massachusetts Institute of Technology (1950), and Ohio State University (1958). His experience included work as a process development engineer with the Oak Ridge National Laboratory in 1949 and with the Nylon Division of E. I. duPont Company from 1950 to 1952 before joining the staff of the University of Dayton Research Institute. During his three and one half years with the Institute Freeh was project supervisor for several Air Force sponsored nuclear weapons effects tests which accented instrumentation.

In the fall of 1955 he became an instructor in the Chemical Engineering Department of Ohio State University while he completed requirements for the PhD degree awarded in 1958. He joined Industrial Nucleonics Corporation as a consultant in May 1958 and served in this capacity until September when he was appointed to the present position, giving him primary responsibility for instrumentation and control systems for the petroleum and petrochemical industry.

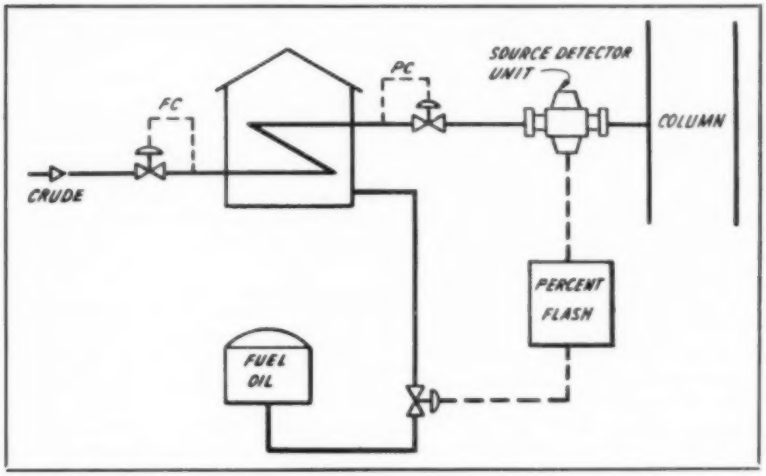


FIG. 6. Percent flash.

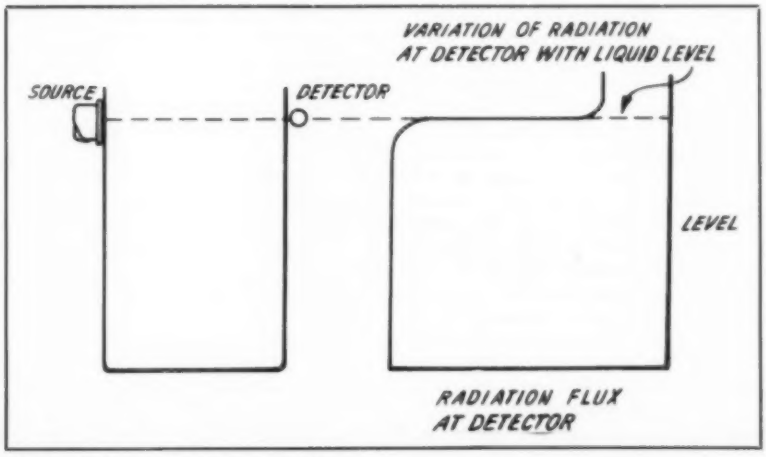


FIG. 7. Fixed point level measurement.

Fixed Point Level

A typical installation for fixed point measurement is shown in Fig. 7. On small vessels the source and detector are generally put across a diameter of the tank on a horizontal line. On the larger vessels it is generally advantageous to shoot a chord of less than a diameter to minimize source size. As a rough guide it can be assumed that there is an advantage to shooting a chord of less than a diameter if the thickness of the wall is less than 10 percent of the radius.

The plot shows the variation in radiation received at the detector as a function of the liquid level. As the level rises in the region below the measuring point there is little influence on the radiation level at the detector until the level approaches to within approximately one GM radius of the horizontal line between the source and the detector, then dropping off slowly again to reach a constant value shortly after the level passes beyond the top of the detector tube. Although the curve above and below the measuring point has been shown flat, in actuality there is a slight departure from this condition due to reflection and back scattering of radiation. However, the effect on the operation of a unit of this type is negligible. For maximum sensitivity or accuracy, the detector is set

to provide an indication when the level rises above or below a level midway between the high and low radiation levels. The control point is positioned at the point of steepest slope on the radiation intensity-level curve. The output is generally in the form of a relay closure, denoting the level is either above or below the measuring point as indicated by the status of the relay.

Continuous Level

One type of source-detector arrangement for continuous level measurement is shown in Fig. 8. The source is placed on one side of the vessel at the high point of the measuring span; the detector is placed on the opposite side of the vessel so that its active length is at least equal to and corresponds to the span at which the level is to be measured. The output from the detector is amplified and sent to a read-out and/or control device. Because of the variation in source-detector spacing between the top and the bottom – the uncompensated output of the detector is not linear with level. If the measuring span to diameter ratio is not too high, it is possible to compensate for this effect. For favorable span to diameter ratios, the output can be made linear to one percent. The continuous level measuring system is used where throttling control is required.

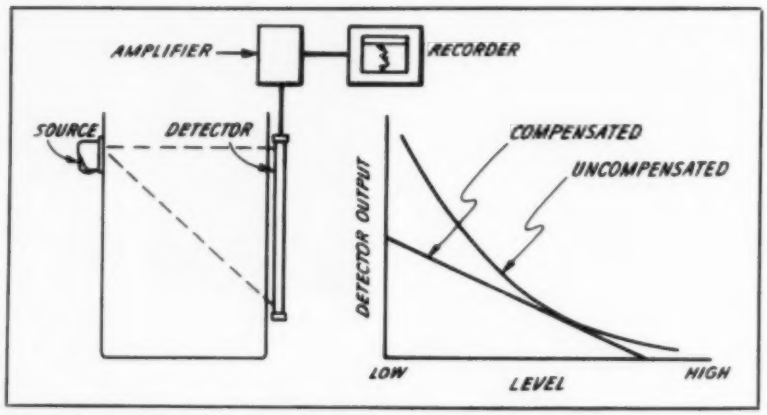


FIG. 8. Continuous level measurement.

Zone Control

In many cases where on-off control is unsatisfactory it is possible to obtain the desired degree of control by zone control without resorting to the usually more expensive throttling action type of control. Zone control can be obtained by using several level detector-controller devices in a hookup such as is shown in Fig. 9. This particular setup shows three detectors, however, either a lesser or greater number may be used. The greater the number of detectors, the closer one can approach throttling action. The middle detector is mounted near the control point. Detectors H and L are mounted above and below this at a distance which depends upon the magnitude of the flow rate variations and vessel capacity. The output of the detectors is used to control an on-off solenoid valve in the instrument air supply to the control valve. The regulating valve in series with the solenoid valve determines the air pressure supplied to the control valve when the corresponding solenoid valve is open. The variations in flow rate with level obtained by means of a control action of this type are shown in accompanying graph. When the level is at detector H or higher air supply to the control valve is zero, the valve is cut off giving a zero flow rate as shown. As soon as the level drops below H the solenoid valve associated with detector H opens, increasing air supply

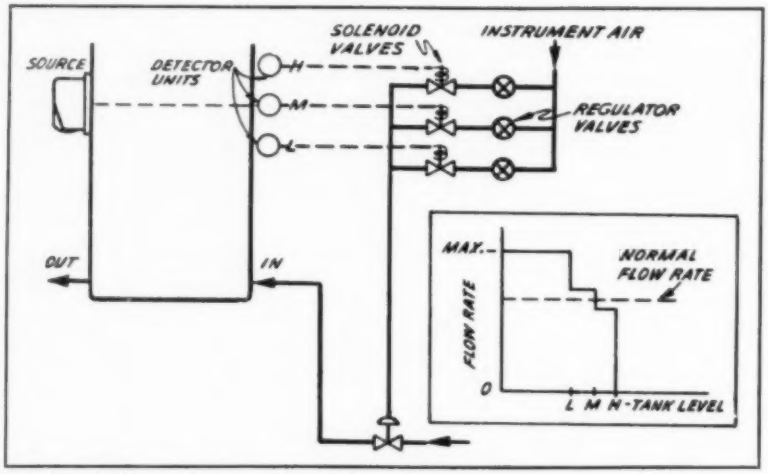


FIG. 9. Multiple zone level control using fixed point level sensors.

to the control valve and bringing the flow rate up to the point shown. The fluid remains at this value as long as the liquid level remains between detectors M and H. As the level drops below M the solenoid associated with M opens, the air supply to the control valve is increased and the flow rate goes up the small amount shown. Again, the flow rate remains constant as long as the level stays between detector L and detector M. If the level drops below L the third solenoid valve is opened, further increasing air to the control valve and the flow rate is increased to the maximum value.

If the vessel is part of a continuous flow system such as a reactor the demand does not change very greatly. When this situation exists the differences in flow rate as the level fluctuates above and below detector M can be made quite small. Further, if capacity is high the vertical spread between L and H can be made small. This means that the flow rate will for the most part vary only a small amount above and below the average flow rate and level fluctuations will be small. Occasionally demand changes will be great enough to cause the level to fall below L or above H resulting in much larger flow rate changes; however, by placing an orifice in the air lines controlled by L and H the flow rate will only tend toward the extremes indicated before the level again returns to the normal control band between L and H.

Summary

The application of radiation gaging techniques to measurement problems in refineries is quite broad. It is hoped that the foregoing discussion of the principles on which these measurements are based and the few examples presented will aid the reader in evaluating the applicability of radiation measurements to specific process problems.

The use of radiation instrumentation as a powerful research tool for special measurements should be apparent. However, the major benefit of radiation measurement is derived from use in routine process control. Fortunately, reliable instruments are now available as standard, well-engineered units, making their routine usage feasible and economical. ★ ★ ★

A Refinery Instrument Engineer's Notebook

On the job observations and notations by an engineer of some representative refinery instrumentation problems

Clarence R. Skalnik
American Oil Company
Texas City, Texas

THE MOST common process variables that instruments measure and control in a refinery are flow, temperature, pressure and level. Here are four problem case histories, detailed by a refinery instrument engineer who encountered and solved them.

Flow Problem

Refinery flows are most often measured with a differential pressure type orifice meter. This involves a carefully calculated restriction orifice installed in a measured length of straight run of pipe of known diameter, and a suitable meter calibrated to measure the pressure drop across the orifice and read out flow quantity on a dial or chart. In these installations maintenance is usually nil, and malfunction is attributed to the complicated-looking flow meter. If checking the meter against a water column shows the instrument in close calibration, the orifice itself is suspected. It usually can be determined if a plugged tap, excessive liquid in a gas line, excessive gas in a liquid line, flashing across the orifice, or hydrate formation is the culprit. Though not always so simple to detect, these usually cause large erratic readings followed by periods of reasonably correct readings.

Seldom suspected is corrosion and/or erosion of the orifice hole or the pipe itself. Sometimes even after visual inspection no difficulty is suspected, and the orifice hole and pipe must be calipered, then checked against original readings.

For instance, 3000 bbl per day of 13.5 API gravity oil at 100 F flowing through a 2½-in. schedule 40 pipe (2.469-in. published inside diameter) and an orifice plate of 1.558-in. inside diameter will create a differential equivalent to a head of 100 in. of water when measured at the orifice taps.

The orifice plate is designed using nominal pipe dimensions, but at times an appreciable error immediately creeps in, as a manufacturer is permit-

Fig. 1.

PRESENT ERROR (NONE)

AFTER 22,000 HOURS IN OPERATION PIPE THICKNESS IS NOW 0.200" WHICH REPRESENTS 0.007"/YEAR CORROSION RATE.

ERROR IN 10 YEARS

WALL THICKNESS IN 10 YEARS = 0.130"

PIPE I.D. IN 10 YEARS = 2.615"

ANTICIPATED CALCULATION $\beta = \frac{1.558"}{2.615"} = \frac{d}{D} = 0.596$

ANTICIPATED CORRESPONDING S FACTOR = 0.2332*

$3000 \text{ B/D} \times \frac{0.2337}{0.2675} = 2615 \text{ B/D}$ ACTUAL FLOWING WHEN METER READS 3000 B/D

$\frac{385}{3000} \times 100 = 12.8\%$ ERROR (LOW)

* S FACTORS ARE TAKEN FROM "PRINCIPLES AND PRACTICE OF FLOW METER ENGINEERING", PAGE 59, BY L. K. SPINK, FOXBORO COMPANY.

FR-20 2½" STD. PIPE METER RUN FOR 3000 B/D
0.975 SP. GR. HYDROCARBON @ 100°F

CALIPERED WALL THICKNESS = 0.220"

INITIAL PIPE I.D. = 2.435"

NOMINAL WALL THICKNESS = 0.203"

NOMINAL PIPE I.D. = 2.469"

INITIAL ERROR

ORIGINAL CALCULATION $\beta = \frac{1.558"}{2.469"} = \frac{d}{D} = 0.631$

CORRESPONDING S FACTOR = 0.2675*

CORRECTED CALCULATION $\beta = \frac{1.558"}{2.435"} = \frac{d}{D} = 0.640$

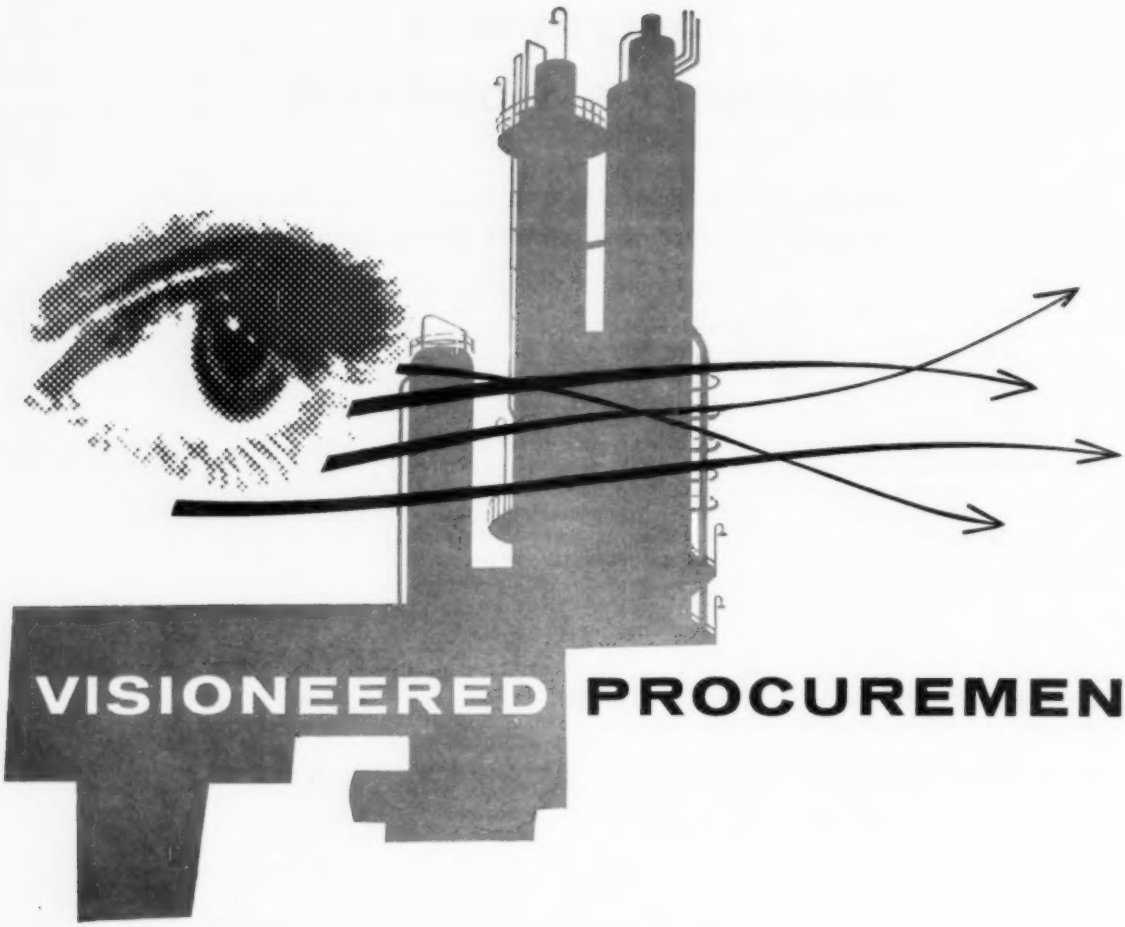
CORRECTED CORRESPONDING S FACTOR = 0.2770*

$3000 \text{ B/D} \times \frac{0.2770}{0.2675} = 3105 \text{ B/D}$ ACTUAL FLOWING WHEN METER READS 3000 B/D

$\frac{105}{3000} \times 100 = 3.5\%$ ERROR (HIGH)

Adapted from a paper presented by the author at the Gulf Coast regional meeting of the Western Petroleum Refiners Association in Houston, 1959. Permission of the WPRA to publish this paper is gratefully acknowledged.

intangibles were never so important



VISIONEERED PROCUREMENT

Procuring the innumerable items for construction of a petroleum, chemical or petrochemical plant is a complex undertaking requiring a high degree of experience and foresight. Working in close coordination with estimating, engineering, drafting, field construction, inspection and expediting personnel, the Procon purchasing staff provides many intangible services of inestimable value. This is another reason why a Procon-built plant is economical in cost, completed on time and superior in performance!

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ted a ± 12 percent deviation in wall thickness of seamless pipe. This is illustrated by the calculations in Fig. 1, where there was an initial flow error of 3.5 percent due to an 8.5 percent increase in nominal wall thickness. Then as the 0.007 in. per year corrosion rate ate away the excess metal for 22,000 operating hours the error was corrected. However, error will accumulate at better than 1¼ percent per year in this particular installation.

This sort of phenomenon will not affect the unit operator very much because the error accumulates over such a long period he never notices it, but it can mean trouble for an engineer asked to run a material balance on the unit or on a tower. The generally accepted accuracy of this type of flow meter installation in refinery service is ± 2 percent, and, as has been shown, this accuracy can be easily usurped by a little corrosion. Fig. 1A shows a practical guide to be used in determining whether the meter should be recalculated using the new pipe ID.

If the orifice to pipe diameter ratio is apt to be changed, it is recommended the tolerance permitted, as shown in Fig. 1A, be the same as given for the maximum orifice to pipe diameter ratio which may be used.

As the curve illustrates, the smaller diameter holes in the orifice permit greater latitude in pipe diameter ID error. For example, a d/D or Beta ratio of 0.70 for a 2-in. meter run with a 0.05-in. error in pipe ID will result in an intolerable 2.5 percent deviation while the same 0.05-in. error in pipe ID for a 10-in. pipe will give the permissible tolerance of 0.5 percent when using flange taps. The pipe ID error and out of roundness error (difference between minimum and maximum pipe ID) upstream of the orifice apply to the curve, while it is recommended the diameter of the downstream section be held to twice the tolerance in the curve.

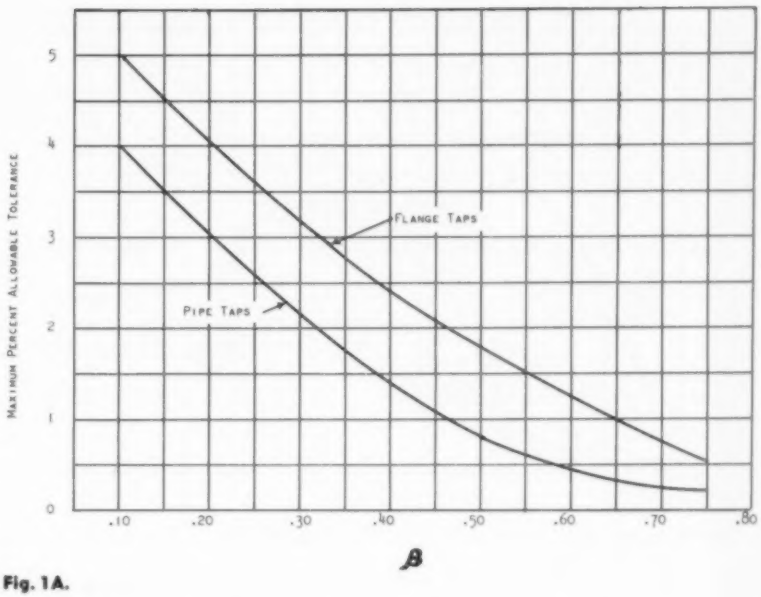

Fig. 1A.

Temperature

Of all modes of measuring process variables, temperature measurement is by far the slowest in indicating a change. This makes temperature control quite unsatisfactory for many applications, but there are times it must be used. In older process units thermowell nozzles were built into the tops of fractionating vessels to measure the temperature in the vapor space, and in some cases this point was also used in a temperature control loop.

The possible difficulty encountered here is shown in Fig. 2 — a cross section of a thermocouple enclosed in a protecting thermowell. Here R_1 is a film resistance tending to prevent an increase in temperature of the hot overhead vapors from reaching the thermowell, C_1 is the capacity of the thermowell to absorb heat before increasing the temperature of the inside wall of the thermowell, R_2 is a film resistance tending to prevent the increased temperature of the thermowell wall from reaching the thermocouple, and finally C_2 is the very small capacity of the thermocouple to absorb heat before generating an e.m.f. relative to the thermocouple temperature. All of these accumulate into "measurement lag," representing the period of time from

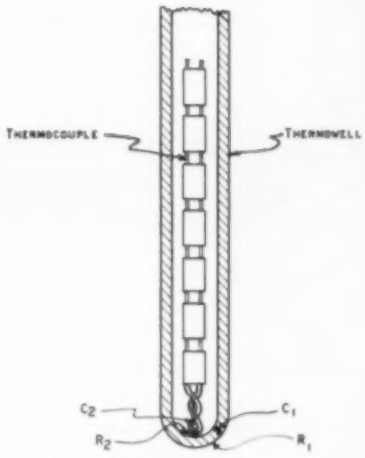

Fig. 2.

an actual change in process temperature, until it is indicated on the measuring instrument. The most difficult problem to overcome is resistance R_1 and getting the process temperature to affect the thermowell. In Fig. 3 time is plotted against percent of temperature change.

These values themselves are not important because there are so many factors that can affect the slope of these curves, but they serve to illustrate the importance of adequate movement of the process gases in order to provide a sufficient speed of response to get satisfactory temperature control. In one pipe still, as shown in Fig. 4, the tower top temperature was controlled by a temperature controller regulating a valve in the reflux line. The temperature sensing thermocouple always got any rapid change in tower top temperature too late to get the controller to

The Author

Clarence R. Skalnik, *a senior design engineer, joined American Oil Company's Texas City refinery as a construction and maintenance engineer in January 1947 after receiving a BS in mechanical engineering from Texas A&M. In 1948, he was transferred to the design engineering division, and has been engaged in instrumentation design work since 1951. For the past four years, Skalnik has served as design coordinator in charge of plant instrumentation, electrical, and air conditioning design. He is president of the Galveston County Chapter of the Society of Professional Engineers, Education Chairman-elect of the Houston Section of the Instrument Society of America and Education Chairman of Region VII of the Instrument Society of America.*

— Courtesy John Wiley and Sons, Inc., Principles of Industrial Process Control, D. P. Eckman.

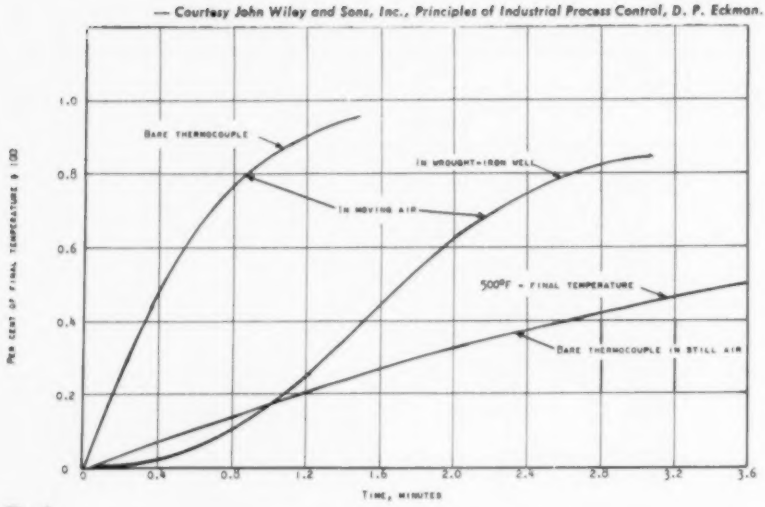

Fig. 3.

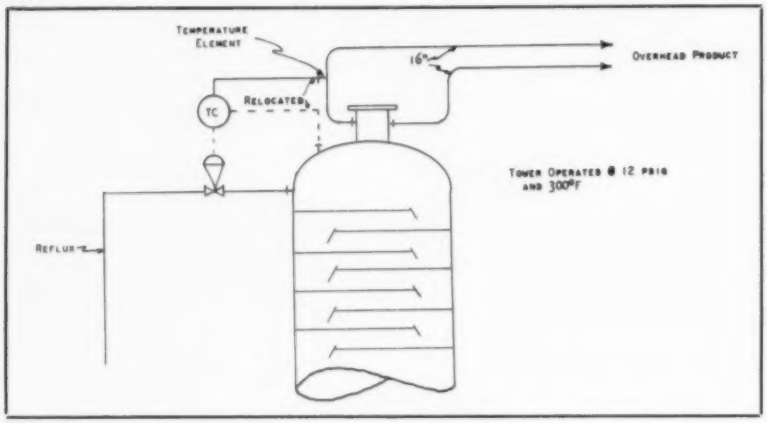

Fig. 4.

cope with it. Temperature continued to shift from the control point faster than the controller could correct for it, or the process temperature would begin to shift back to the control point while the controller was still trying to make a big correction. In either case it was necessary for the operator to go on manual control to line out the tower again.

This problem was solved by relocating the thermowell from the tower to the overhead vapor line where the much higher vapor velocities did a better job of overcoming the film resistance R_1, permitting the instrument to sense a temperature change much sooner and do a more satisfactory job of controlling.

Pressure

Pressure control problems involving local mounted close coupled pressure controllers are rare. These instruments have a very fast speed of response and usually do not require very much capacity of the volume being pressure controlled, but there is a limit as to how small this volume can be. For example, in a 1000 cu ft drum at 300 psig with an incoming gas flow that ranged from 4 to 6 std cu ft per min, a man could easily maintain the pressure in that drum between 299 and 301 lb by controlling the discharge with an occasional adjustment of a little needle valve.

Compare this to Fig. 5, where a slightly varying flow of about 5000 std cu ft per hr of fuel gas is dropped from 300 psig through a pressure con-

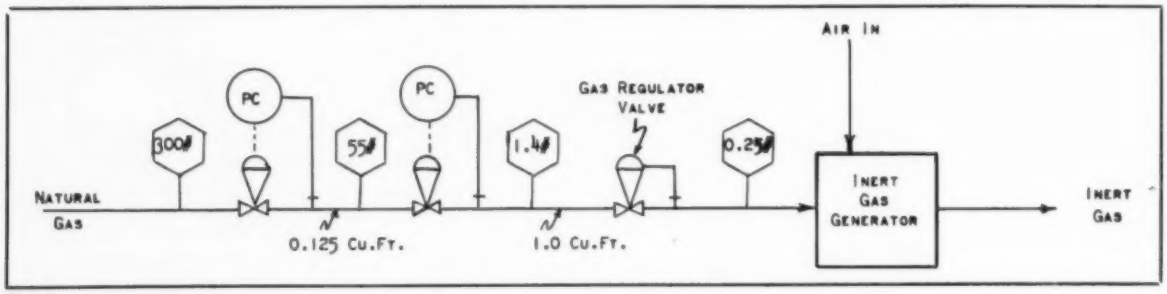

Fig. 5.

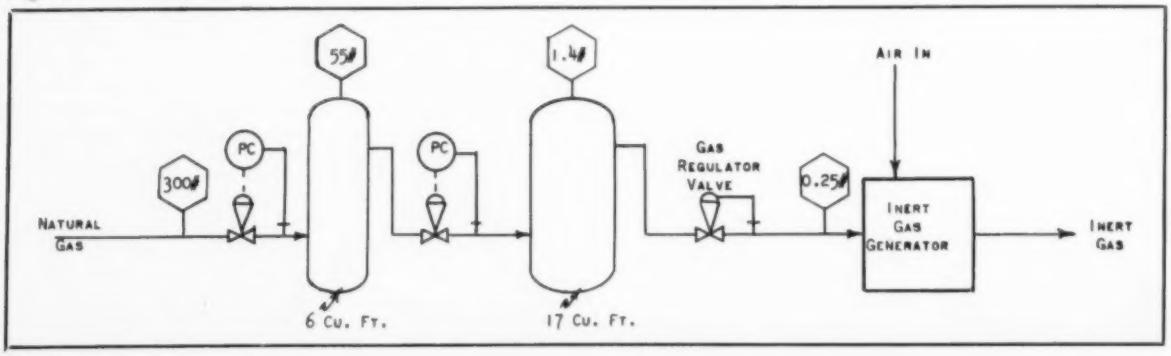

Fig. 6.

Powerforming

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DESCRIPTION: This fixed-bed catalytic reforming process uses a platinum catalyst that is regenerated periodically to maintain high activity. Process can make 85-100+RON clear reformate from low-grade naphthas or be used to make aviation gasoline blending stocks or to give high yields of aromatics.

In addition to the reactor system, Powerformers include a feed Hydrofiner, a recycle gas system and a stabilizer. Typical reactor system consists of four reactors on oil, a swing reactor, preheat and reheat furnaces, and catalyst regeneration facilities.

With favorable feedstocks and where only moderate octane improvement is desired, the swing reactor may be deleted and an intermittent regeneration system using fewer reactors and a period of several months between regenerations may be employed.

CATALYST REGENERATION: Catalyst regeneration facilities are typically designed to regenerate catalyst in a reactor in 16-24 hours. In a unit with four on-oil and one on swing, entire catalyst charge could be regenerated in 80-120 hours.

FEEDSTOCKS AND PRODUCT YIELDS: Typical feeds consist of naphthas boiling from 160 to 400 F. Product yields and quality are shown below for five stocks reformed to 100 RON clear.

Feed Source	Arabian (1)	Arabian (2)	Redwater (3)	Mixed La. (4)	W. Texas (5)
Nominal cut range, °F.	160/300	300/385	170/310	200/330	200/300
Feed Properties					
Gravity, °API	61.6	49.6	57.2	55.0	53.0
Research O.N. clear	42	26	58	58	56
ASTM 5% point, °F.	190	310	220	223	235
ASTM, 50% point, °F.	236	342	241	253	260
ASTM 95% point, °F.	294	380	288	304	291
Watson K Factor	12.1	11.9	11.9	11.8	11.7
Yields, % on Feed					
C_5 plus, vol. %	64.3	78.3	73.5	77.5	81.0
H_2, wt. %	1.3	1.3	2.4	2.1	2.0
C_1, wt. %	2.3	1.3	2.1	1.7	1.5
C_2, wt. %	5.9	2.8	3.7	2.9	2.5
C_3, wt. %	10.0	5.7	8.2	5.1	4.4
C_4, vol. %	15.0	8.4	10.7	8.8	7.8
C_5 plus Powerformate Properties					
Volatility, % D plus L @					
158 °F.	22	2	9	4	5
212 °F.	50	16	43	29	21
257 °F.	73	29	66	60	59
302 °F.	90	45	89	84	85
356 °F.	97	74	97	96	98
ASTM Final B. Pt. °F.	392	444*	396	402	385
Gravity, °API	49.0	40.0	47.5	45.9	44.3
RVP, psi	7.5	2.7	4.5	4.0	3.5
Octane Numbers					
Research clear	100	100	100	100	100
Research + 3cc TEL	105.6	105.6	105.6	105.6	105.6
Motor clear	88.6	88.6	88.6	88.6	88.6
Motor + 3cc TEL	94.6	93.2	93.6	93.1	93.1

*Before rerunning

SERVICE FACTOR: 95 percent.

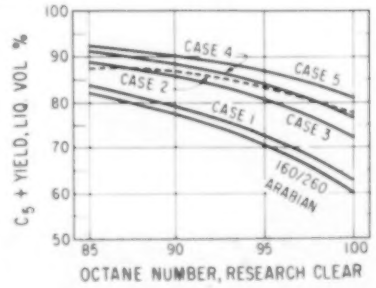
OPERATING PERSONNEL: Two-four men per shift.

UTILITIES: Based on typical 10,000 B/SD unit.

Steam	2,000 lb/hr
Power*	2,500 kw
Cooling Water (25° rise)	3,700 gpm
Direct Fuel	150 MM Btu/hr

*Based on electric motors for all pumps and compressors.

INVESTMENT: Varies with capacity, location, type of feed, and octane number desired.



Model IV Fluid Catalytic Cracking

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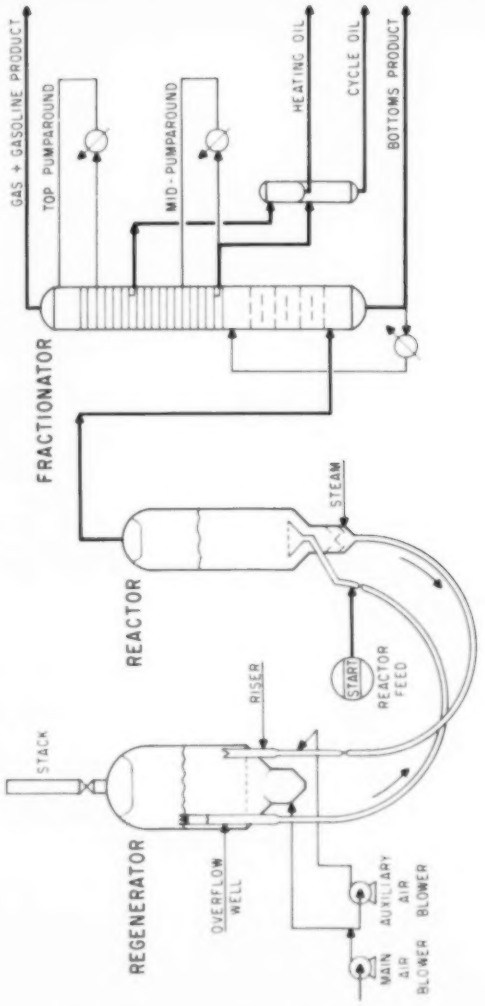

OPERATING CONDITIONS:

	°F	psig
Reactor	875-975	10-20
Regenerator	1100-1150	10-20

Catalyst — Synthetic or Natural

Model IV Fluid Catalytic Cracking

Licensed by: Esso Research and Engineering Company

DESCRIPTION: Reactor and regenerator vessels are mounted side by side at low elevation. U-bends are used to transfer catalyst from vessel to vessel at moderate velocities. In place of slide valve control of catalyst flow rates, a portion of regeneration air is injected at varying rates into the spent catalyst riser. Changes in air rate vary density in the riser, thus causing changes in flow rate between the vessels.

Catalyst in the U-bends acts as seal between the vessels, also impedes reverse flow during upsets. A slide valve is provided in each U-bend for full shut-off in extreme emergency. The valves are normally full-open, thus no erosion problem is presented.

All spent catalyst plus control air enters the regenerator above the grid. Remaining air for combustion enters from beneath the grid.

It is customary to run the unit in heat balance; no preheat furnace or regenerator cooling is required except when greater operating flexibility is desired.

FEEDSTOCKS AND PRODUCT YIELDS:

A variety of gas oils can be processed, including vacuum distilled oils boiling up to 1100-1150 F. Deasphalted oils boiling up to 1200 F can also be included. A comparison of yields for cracking light and heavy fractions of West Texas crude is given below.

Feedstock:	Light Gas Oil	Vacuum Gas Oil
Feed Inspections		
Gravity, °API	33.4	22.3
20% TBP, °F	494	684
50% TBP, °F	536	828
80% TBP, °F	587	984
Con. Carbon, Wt. %	0.06	0.9
Operating Conditions		
Temperature, °F	930	930
Conversion, Vol. %	60.5	58.2
Product Distribution		
C_3 and lighter, Wt. %	10.7	6.0
Butanes, Vol. %	10.8	3.0
Butylenes, Vol. %	5.8	7.5
Gasoline (10 lb. RVP) Vol. %	39.8	52.3
Heating Oil (620°F. E.P.), Vol. %	37.5	29.4
Heavy Gas Oil, Vol. %	2.0	12.4
Coke, Wt. %	4.1	4.4
10 lb. RVP Gasoline		
Octane No., F-1 Clear	99.0	94.5
Octane No., F-2 Clear	85.2	80.0

PROCESS VARIABLES:

By altering catalyst circulation rate, holdup, reactor temperature, recycle feed, etc. wide flexibility in product distribution can be attained. The table below shows product distribution possible with a typical 25 API vacuum gas oil.

MODEL IV PRODUCT DISTRIBUTION

Type Operation	Once-Through	Recycle Mod-erate	Recycle High
Product Distribution			
Dry Gas, Wt. %	8.5	8.6	8.5
Total C_4, Vol. %	17.1	16.5	15.6
C_5-430°F., Vol. %	43.8	51.8	57.0
Heating Oil, Vol. %	17.3	20.1	24.1
Heavy Gas Oil, Vol. %	18.9	8.8	2.0
Carbon, Wt. %	7.0	7.0	7.0

SERVICE FACTOR: 95 percent.

OPERATING PERSONNEL: Two-four men per shift.

UTILITIES: Based on typical 10,000 B/SD unit.

Steam	8,300 lb/hr
Power*	3,000 kw
Cooling Water (25° rise)	5,000 gpm
Direct Fuel	none

*Electric motors for all pumps and compressors, includes product gas compressor.

CATALYST REQUIREMENTS:

Inventory:
Approx. 20-30 lb/daily B Feed
Consumption:
Approx. 0.1-0.5 lb/daily B Feed

INVESTMENT: Varies with capacity, location, type of feed, severity of operation, and degree of flexibility required.

Powerforming

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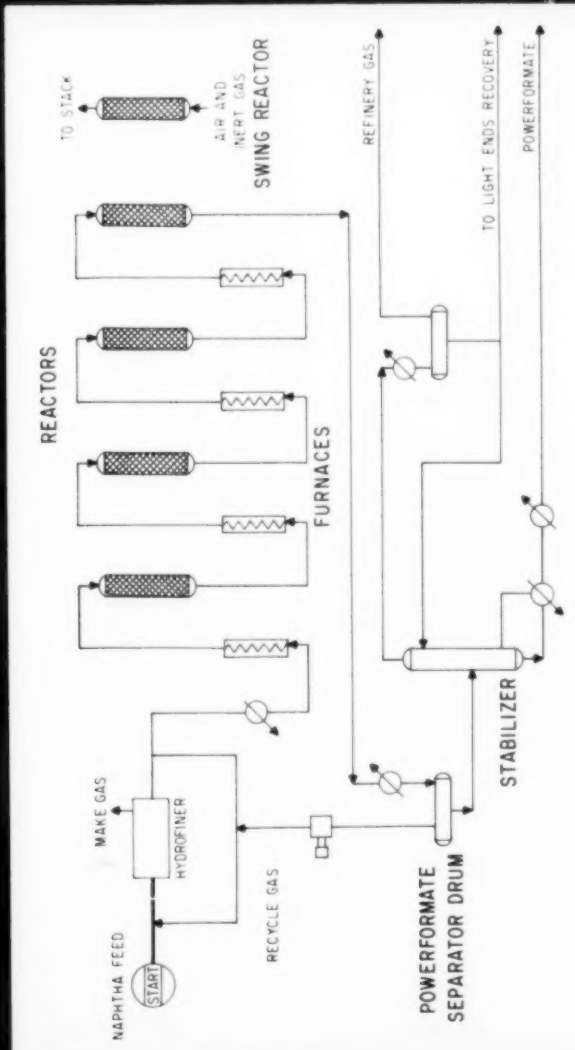

OPERATING CONDITIONS:

Average pressure, psig	300-450
Reactor inlet temperature, °F	900-1000
Recycle Gas Rate, SCF/Bbl.	4000-6000
Space Velocity W/Hr/W	1-4
Catalyst	Platinum

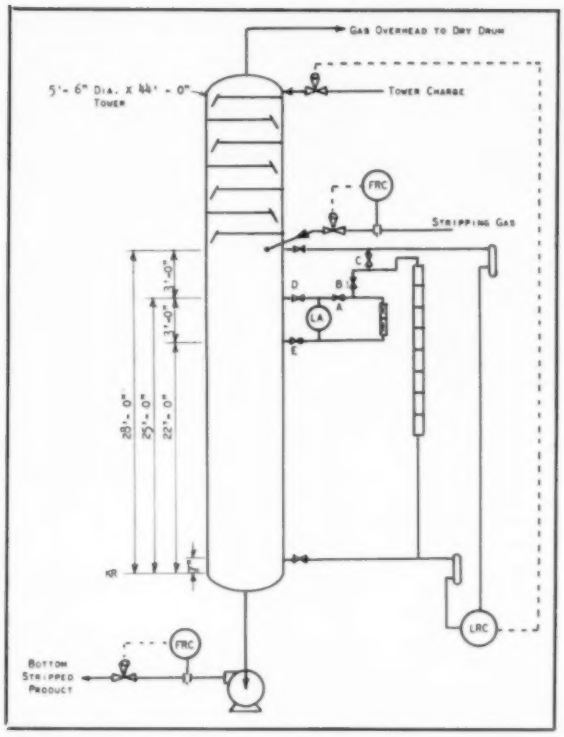

Fig. 7.

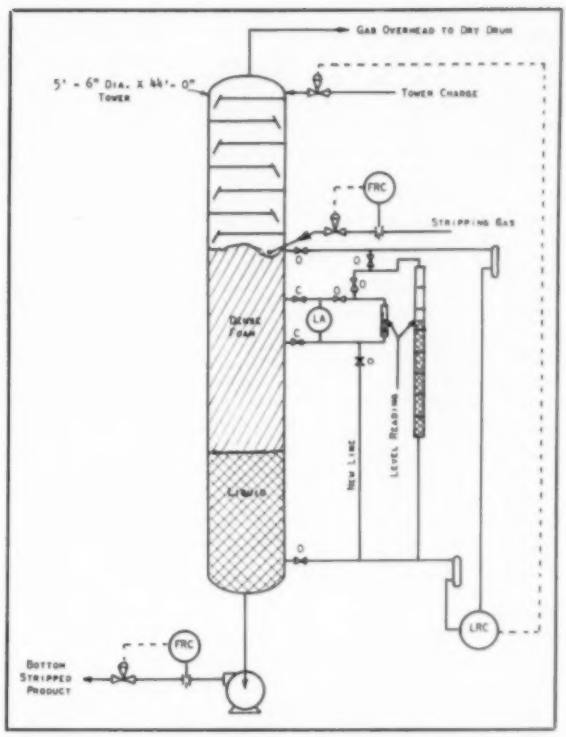

Fig. 8.

trol valve that is trying to maintain a pressure of 55 psig in a 0.125 cu ft volume that is in turn expanding through another pressure control valve that is trying to maintain a pressure of 22 oz. in 1 cu ft volume that is in turn expanding through a gas pressure reducing valve into the mixing carburetor of an inert gas generator. Obviously this could not be accomplished by hand control, and actually could not be done with the existing instrumentation following even small load changes. The pressures would swing wildly and eventually the flame in the inert gas generator would go out.

This problem was solved by installing two drums (one 1 ft by 6 ft high and one 1 ft 8 in. by 6 ft high) in the system as shown in Fig. 6, increasing capacity of the system and thus making control easier.

Level

The basic principle of the simple level gage is that the liquid in two interconnected vessels will seek a common level. However, a false level phenomena in steam drums, ammonia evaporators, or other services where the liquid is at its bubble point have been observed. In one case, a false level occurred in a clean vessel containing a free flowing liquid well below its bubble point.

Basic details are illustrated in Fig. 7. The 5 ft 6 in. diameter by 44 ft high tower is a simple stripper and was converted from an unused vessel in which all but the top seven trays were removed. The remainder of the tower is surge capacity and contains no baffles, trays, or reboiler. Tower charge is level controlled and enters over the top tray while the flow controlled stripping gas is injected beneath the bottom tray. The gas leaves the top of the tower and goes to a dry drum, and a pump takes suction from the bottom of the tower. This latter stream is flow controlled also. An eight-section reflex gage glass spans the bottom 28 ft of the tower and shares taps with the recording differential pressure type level controller. At about the 23-ft level and below the bottom tray, a low level alarm was provided to prevent loss of level in the tower. It is essential not to lose level because gas filling of the suction line requires extensive bleed-off to re-establish suction.

The low level alarm was checked daily by bleeding off the float chamber to simulate low level, causing the alarm to sound. One day a very low level was observed, but the alarm did not sound. As a quick check, the float chamber was bled off again, and the alarm sounded as expected. The stripper tower was removed from service for routine tower inspection and to repair the level alarm. As the tower was being pumped out the alarm sounded, but at an extremely low level indication on the recording level controller and the gage glass.

Inspection of the tower and low level alarm revealed no defects or explanation for the malfunctioning. However, during this shut down a 2-section reflex gage glass was installed in parallel with the low level alarm to aid in the investigation.

When this equipment was placed back in service it was noted that the level was midway in the top glass of the newly installed 2-section level gage, and the low level alarm was satisfied. But at the same time the level in the long multi-sectioned level gage was a full 4½ ft lower — actually below the bottom tap of the low level alarm.

This led to experimenting with the valving as identified in Fig. 7 and observing levels. In the first series of three steps, the level control set point was at 70 percent level and all the valves were open except for *B* being closed. This first step duplicated the initial problem where the short section of level gage showed a level at a point 23 ft 6 in. above the tower lower knuckle radius while the long level gage showed the level to be about 19 ft. In the second step, valve *A* was closed and *B* opened. This put the short gage across a 6-ft section of the tower instead of the 3-ft section, and put both level gages on the same upper tap. The liquid rose out of sight on the short gage, but remained stationary for the long gage. The third step in this series was to close valve *C* and open *A*. This

connected both level gages to the same upper tap as used by the level alarm. The liquid in the short level gage dropped back to the 23 ft 6 in. level, and the liquid in the long level gage dropped 6 in. to the 18 ft 6 in. level.

A second series of steps consisted of raising the level controller set point, and when the level stabilized the above three steps were repeated. In the first step the liquid in the short gage rose to a 23 ft 9 in. level, and the liquid in the long gage rose to a 21 ft level. In the first step in this series the liquid in the short gage rose only a few inches while that in the long gage rose two feet. A repeat of the valving conditions of the second step in this series showed the level again rising out of sight on the short gage and remaining stationary at 21 ft on the long level gage. Then in the third step the liquid in the short gage dropped to the first step level of 23 ft 9 in. and that in the long gage dropped to the 19 ft 8 in. level.

A stripping tower of this sort is an efficient foam maker, but foam is usually mostly bubbles and very light and was generally discounted as a serious contributor to the problem. However, an observation was made that the gas bubbles in the foam from this tower were extremely small. Since these tiny foam bubbles were observed at atmospheric pressure, they would be about a fourth this size at the tower pressure of 45 psig, a very dense foam.

The problem was then attacked from this angle, and Fig. 8 is included to amplify this point. Referring to the first step in the first series where a short level gage is across a 3-ft section of tower, it was assumed that it was entirely in the foam region. Also, the liquid in the level gage was essentially defoamed since it acted as a stilling chamber. As the liquid in the short gage was indicated to be about two-thirds the distance between the taps it meant the foam was 0.667 times or two-thirds as dense as the liquid.

Should the actual level be below both bottom taps, and the foam extended above the top taps, the level shown by the two gages would vary only with foam density. Second, if the actual level was below the bottom tap of the short level gage and above the bottom tap of the long level gage while the foam covered both top taps, only the long gage would reveal a change in liquid head. However, even then it would not be reliable because a three foot change in liquid head in the vessel would only reflect as a one foot change in level gage reading. Most plausible possibility from the noted results is for the actual liquid level to be between the bottom taps of the long and short level gages. Also, since the stripping gas blasts into the tower just beneath the trays and at the same elevation and quadrant as the top tap of the long level gage, the effective foam head is somewhere near this level. It was previously determined that the foam was about two-thirds the density of the liquid, so if the foam top elevation remained approximately the same and the level controller was set to increase the level one foot, the actual level in the vessel would have to rise about three feet.

The key to the solution of the problem was the addition of the short auxiliary level gage, because when the level rose to this point the rate of level rise would be the same for both gages. The level alarm and its adjacent short checking level gage were retained because the long level gage was only visible from the tower base, so all level instruments were connected across the same taps. These spanned as much of the tower liquid holding space as possible — about 28 ft. Since the two gages were now in parallel, they both agreed as to tower level.

On checking the corrected installation one cold day it was observed that the two level gages still did not check. On successive days the levels varied from 3 to 9 in. of each other. The long level gage was now the one reading consistantly high. It was noted that since the liquid being measured tended to become rather viscous in cold weather, all leads and level gages must be steam traced and insulated. The newly installed long bottom leg of the short gage glass was steam traced, but the line was not insulated yet. Unequal gravity was being caused by temperature difference in long flowmeter lead lines. Where a gravity difference of 0.0125 exists between two 20-ft vertical lead lines a 3 in. difference in head will result (0.0125 by 20 ft by 12 in. per ft = 3 in.). The same is true in this level problem, and a very small difference in gravity can make a large difference in liquid head.

Bibliography

1. Eckman, D. P., Principles of Industrial Process Control, 1945, John Wiley and Sons.
2. Gas Measurement Committee Report No. 3 (1955), New York, American Gas Association.

★ ★ ★

Electronic Measuring Technique Reduces Cost of Corrosion Control

A new electronic measuring technique has been developed that promises to sharply reduce the cost of controlling internal corrosion in process equipment and pipelines.

Internal corrosion is generally controlled by the addition of inhibitor chemicals. These serve to protect the metal surfaces against attack. The exact amount of inhibitor to do the job has been difficult to determine, however. Usual method has been to measure the weight loss of small metal coupons after they have been exposed to the corrosive atmosphere for several days, weeks, or months. The amount of inhibitor is varied to find a safe corrosion level.

The new technique provides a daily, or even an hourly record of corrosion attack. Capable of detecting as little as a millionth of an inch of corrosion, the method gives process engineers a way of judging the effect on corrosion, almost immediately, of even small changes in process conditions or inhibitor concentrations.

In one field test, for example, addition of an inhibitor reduced the corrosion rate by 75 percent within a day and a half. The curve then flattened out, however, and engineers suspected that the specified dosage was not actually entering the system. An inspection revealed that the pump metering the inhibitor into the system was at fault. Once this was corrected, the corrosion-rate curve resumed its downward drop, stopping at 5 percent of the initial rate.

The new measuring technique also allows plant engineers to run rapid comparison tests between competitive inhibitors, permitting them to choose the compound that will provide the most protection at least cost.

The corrosion-measuring method utilizes special "probes" consisting of two elements made from the same type of metal used on the processing equipment, one exposed to the corrosive environment, the other protected by plastic or ceramic. As the exposed element corrodes, its resistance increases. By using a special instrument which measures the resistance ratio of the exposed element to the protected element, a direct indication of corrosion is obtained. (With both elements at the same temperature, heat variations cannot affect the results.)

The probes and associated electronic measuring instruments were developed by Crest Instrument Company, a division of Magna Products Company.

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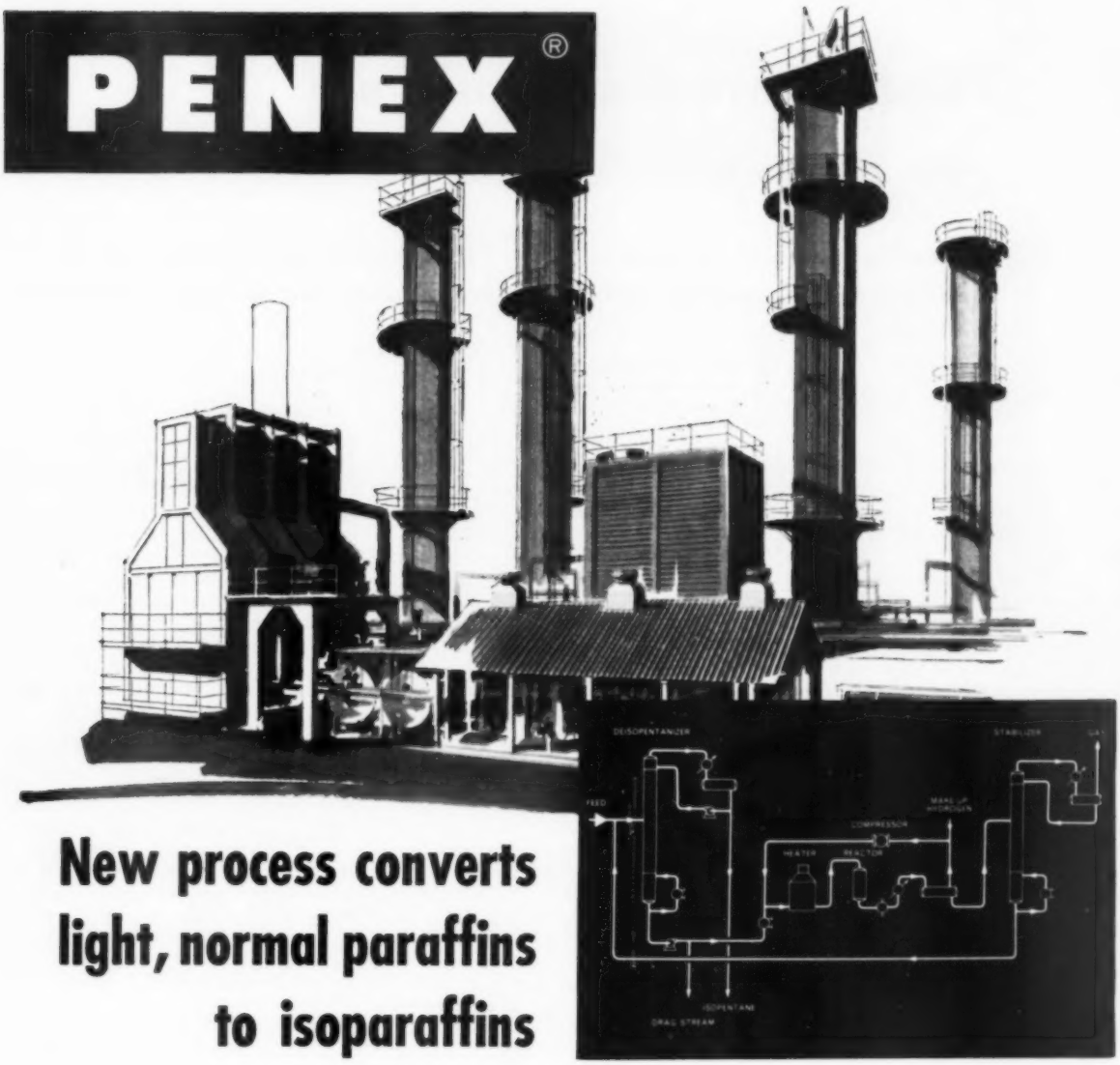

New process converts light, normal paraffins to isoparaffins

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Use Vibration Analysis to Pinpoint Trouble

Possible failure of centrifugal pumps, compressors and turbines can be anticipated or corrected well in advance by using the techniques described

Lewis N. Dawson
Sinclair Refining Company
Marcus Hook, Pennsylvania

OFTEN TO THE INEXPERIENCED OPERATOR a critical pump or compressor will appear to operate perfectly at one moment and become a total loss the next. Of course, this is rarely so. In most cases, the failure was triggered by a worn bearing or a loose wear ring, or by imbalance caused by scale. In fact, any one of a dozen causes will warn the experienced operator hours, days or even weeks ahead. The alert is given by the tell-tale sign of abnormal vibrations.

The Vibration Analyzer

Trouble-shooting on pumps, compressors, fans, blowers, electric motors and many other items of refinery equipment can be simplified by using a portable electronic vibration analyzer.

Several refineries use a typical portable analyzer, as shown in Fig. 1. This analyzer consists of an inductive pickup which transforms mechanical vibrations into a corresponding electrical signal whose voltage is directly proportional to the amplitude of vibration. This signal is amplified in an electronic circuit and is registered in an amplitude meter and a frequency meter. The amplitude meter reads displacements directly in cycles per minute.

The pickup is equipped with a probe to reach otherwise inaccessible parts of operating equipment. A variable electronic filter allows tuning to each source of vibration without interference from other components while the entire machine under study is in full operation.

A stroboscopic lamp housed in a flashlight-type case is included. It is nomally triggered by the vibration to facilitate location of the source. It is also used to measure the relative phase of vibration due to imbalance in a rotating component. The stroboscopic lamp may also be manually controlled.

The analyzer is rugged and light enough to be taken into the field, yet can be adapted readily for use as a shop balancing machine.

Operating the analyzer does not require an engineering education. The readings are direct and no elaborate calculations are required to suit it for operation by refinery machinists. The readings are quantitative and reproducible.

Procedure

Here is an outline of the general procedure followed in analyzing vibrations in a pump or turbine.

First, obtain as detailed a drawing of the equipment as possible and determine the speeds of its various rotating components. Next, gather as much background information as possible from operating and maintenance personnel. This shows where trouble areas have been indicated. If possible, without disturbing operation, the machine is shut down and vibration is checked at the critical point.

Sometimes rather surprising results are obtained. It is not uncommon to find outside vibration being transmitted to the unit in question. Thus, the analyzer can establish the limit below which vibration cannot be eliminated.

In the next step, the machine is brought up to operating speed and readings are taken on the critical points to determine the major cause of vibration. The analyzer's variable frequency filter is used to scan the range of frequencies and select the frequency at which vibration of excessive amplitude is being obtained. If the machine construction is such that the faulty member is exposed, then the stroboscopic lamp may be used to "freeze" its motion and to determine the phase or angle of imbalance, and to check after correction has been made.

Balancing rotating elements after repair or cleaning in the machine shop pays off in improved bearing, seal and packing life. It reduces field labor. In one case, a repaired turbine with a shop-balanced rotor vibrated on start-up. Since the rotor could be eliminated as a source, the seat of trouble was quickly located in the governor.

Vibration Tolerances

Exact tolerances for allowable vibration may be established when accurate means of measurement are available.

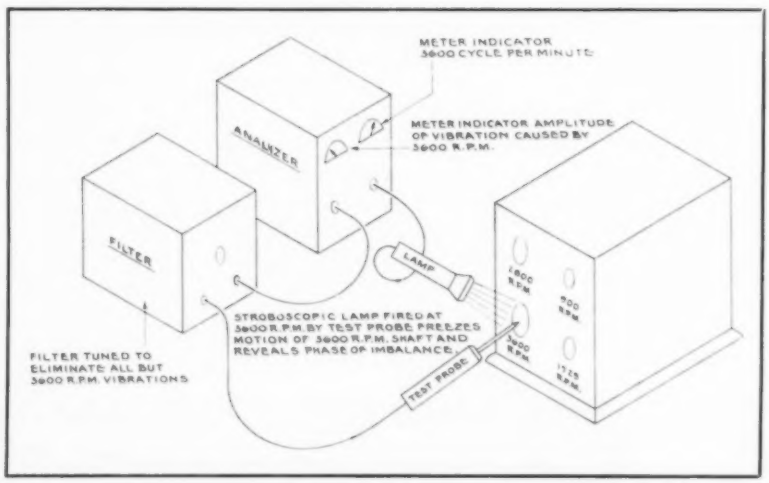
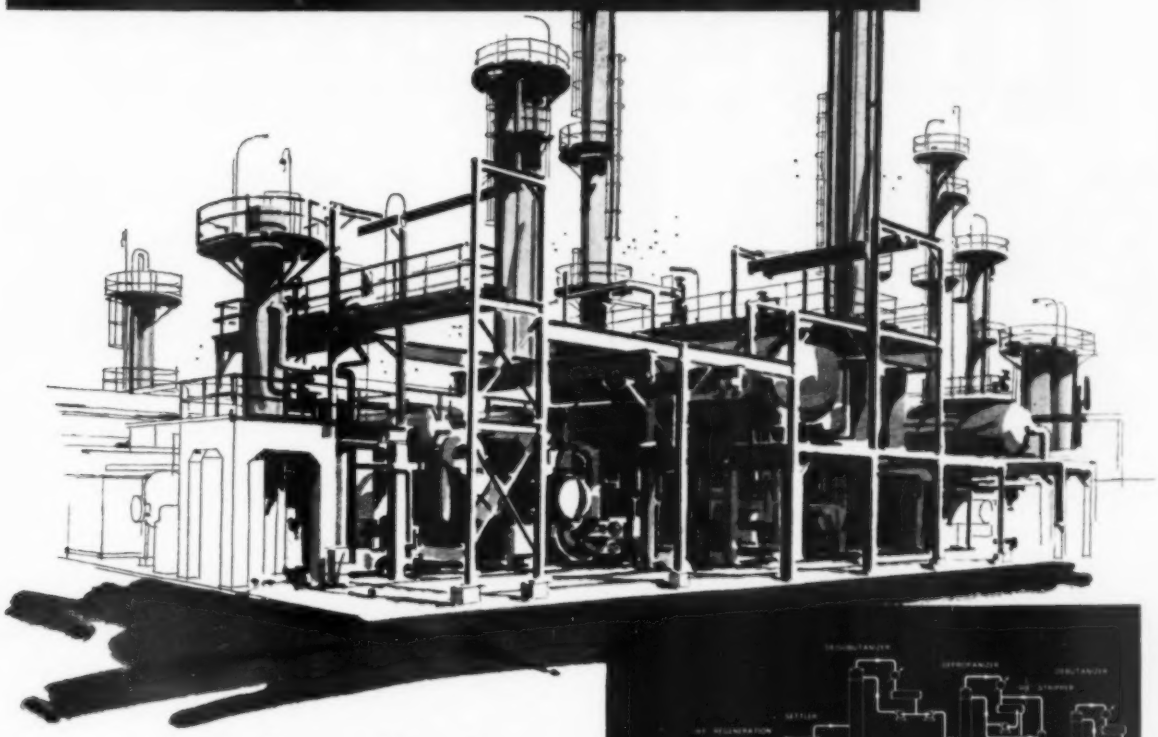
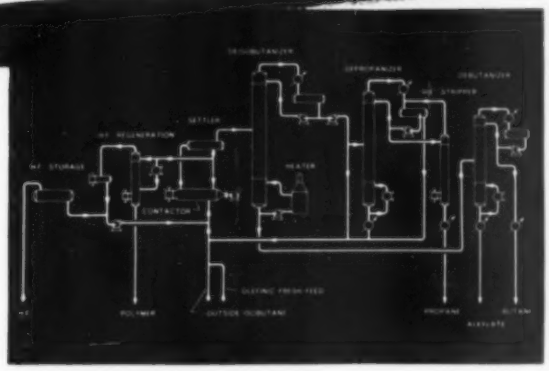

METER INDICATOR 3600 CYCLE PER MINUTE
METER INDICATOR AMPLITUDE OF VIBRATION CAUSED BY 3600 R.P.M.
ANALYZER
FILTER
LAMP
1800 R.P.M.
900 R.P.M.
3600 R.P.M.
1715 R.P.M.
STROBOSCOPIC LAMP FIRED AT 3600 R.P.M. BY TEST PROBE FREEZES MOTION OF 3600 R.P.M. SHAFT AND REVEALS PHASE OF IMBALANCE.
FILTER TUNED TO ELIMINATE ALL BUT 3600 R.P.M. VIBRATIONS
TEST PROBE

FIG. 1.

HF Alkylation





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Motor alkylate, an isoparaffin fuel component, burns with a minimum of carbon deposits even in today's modern high compression automobile engines and thus greatly reduces surface ignition and its consequent "rumble."

Another method for producing alkylate is also available to refiners through UOP. It is similar to the "HF" method but uses sulfuric acid as the catalyst. This process is licensed by Universal Oil Products Company under their own patent rights and the patent rights of Shell Oil Company, The Texas Company, The British Petroleum Company, Limited and Standard Oil Company of New Jersey.

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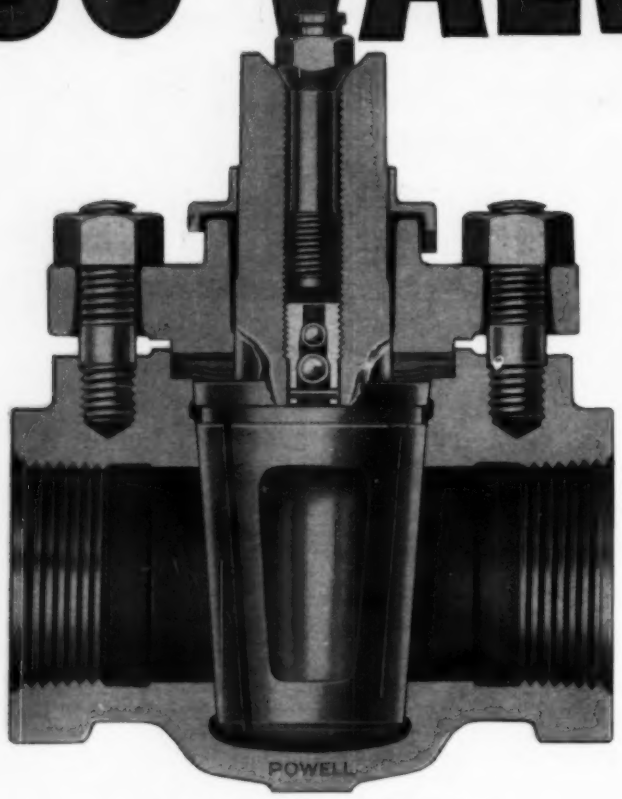

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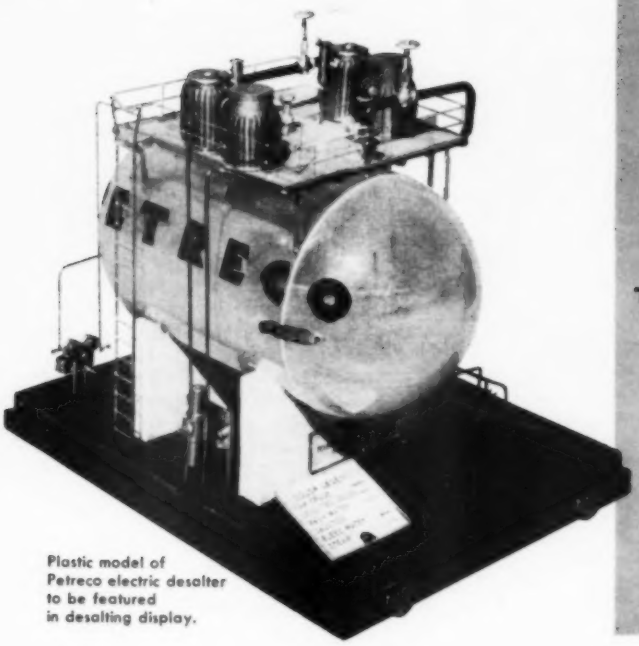

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The manufacturer is usually best qualified to determine the magnitude of allowable vibration in a piece of equipment.

The user can modify the manufacturer's tolerances after establishing a file of vibration measurements over a reasonable period of time. Such modification is sometimes advisable as a result of environmental vibration upon a particular piece of equipment. A tolerance should be established as an amplitude measured at a given frequency at a fixed point on the machine in question.

As a general guide the reader is directed to two very well written specifications. The N.E.M.A. Mechanical Drive Steam Turbine specification provides as follows:

"The vibration of a turbine, at any specified operating speed up to full rated speed, when measured on the shaft adjacent to the bearing support, shall not exceed:

Rated-speed, rpm	(Double amplitude or total travel in any direction) Vibration, in.
Up to and including 4000	0.0030
4001 to 6000	0.0025
Above 6000	0.0020

For speeds below the specified operating speed range and between rated speed and tripping speed, the vibration shall not exceed 0.003 in. double amplitude or total travel in any direction.

Where it is not possible to measure vibration on the shaft, the total amplitude of vibration shall be measured at both bearings on the bearing housing and shall not exceed 50 percent of the foregoing values."

Fig. 2 is taken from U. S. Government standard MIL-STD-167 (Ships) which requires that amplitudes of vibration shall be held within the limits indicated on this chart. Turbine measurements are to be made on the shaft adjacent to the bearings. On other machinery, amplitudes of vibration are to be measured in the bearing housing in the direction of maximum amplitudes.

The specification cautions that these tolerances may be too high for complex machinery, such as assemblies employing reduction gears.

In this chart, amplitude is defined as the maximum displacement of sinusoidal motion from the position of rest or one half the total excursion. Its value is expressed in plus or minus in. or plus or minus mils (0.001 in.).

The real "pay-out" of an analyzer is derived from its ability to pin point the source of malfunctioning. The mechanics thus have a fairly accurate idea of what needs repair. As a result, an extended shut down with incident loss of production may be reduced to the few hours necessary for replacing a particular bearing or resetting a governor valve. Costly dismantling of intricate equipment may thus be avoided.

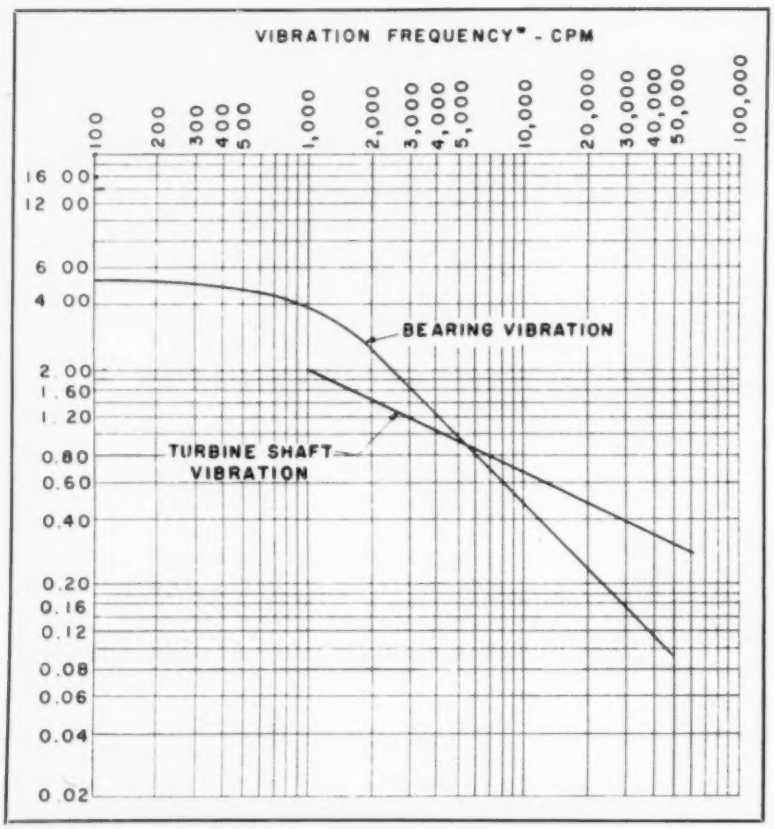


FIG. 2. Maximum allowable vibration.

The Author . . .

Lewis N. Dawson *is a senior engineer at Sinclair Refining Company's Marcus Hook, Pennsylvania, refinery. A 1939 graduate of Stevens Institute of Technology in mechanical engineering, he has been engaged in construction, maintenance and start-up work for Sinclair since graduation.*

Application

The scope of the instrument is further illustrated by citing some causes of malfunctioning:

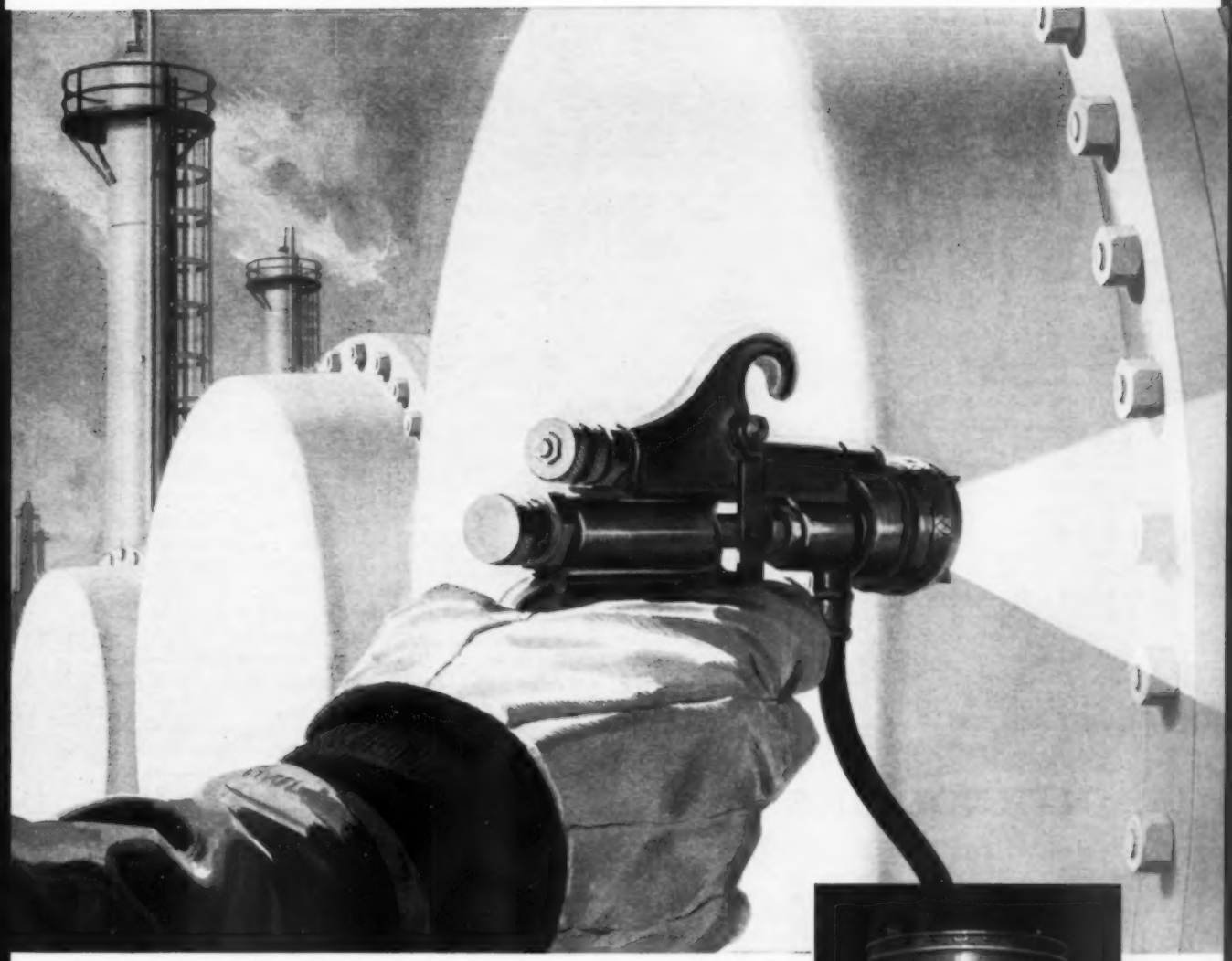
1. A mechanical failure such as rubbing, loosening or excessive wear often sets up a vibration frequency twice that of the speed of the rotating member concerned.

2. In fairly uncommon incidences pumps may start to vibrate after extensive service. This is the result of worn bearings or of wear in closely fitted internal parts that either serve as bearings or provide a substantial damping effect.

3. In equipment utilizing pressure lubrication systems, oil whip in sleeve bearings usually sets up a vibration equal to one half the rotational speed.

4. Tooth interference between mating gears will set up a vibration in one gear equal to the product of the number of teeth in the gear and the gear rpm. This is true, of course, only if the tooth interference applies all around the gear. For instance, if only three teeth are defective, the vibration will have a frequency three times the gear rpm.

5. A 3600 rpm reflux pump had required excessive maintenance, though its alignment was well within recommended tolerances. It showed slightly excessive vibration, 0.003 in. at 3600 cycles per min. However, when the filter was used to check vibration at other frequencies, vibration was recorded at 7200 cpm, or twice the rotative speed. Therefore, some component had to be loose, since misalignment had been eliminated as a possible source. The pump was shut down, opened, and a loose impeller discovered and repaired. After return to service, the pump established a normal maintenance record.



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Humble coatings last six months to a year longer than most other paints. You save *two* ways — on paint and labor. The *third,* and most important, way you save is this: you get better protection, which means longer life for expensive equipment.

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Low Speed Equipment

Balancing comparatively low speed equipment had a surprising effect. For example, balancing of 1200 rpm screw type pump rotors used for handling catalyst fines on a fluid catalytic cracking unit showed a three to one advantage in service life over unbalanced rotors. We now balance all new and repaired rotors as a matter of course.

Fans, Pumps and Turbines

Large induced or forced draft fans can be dynamically balanced in place. This has reduced bearing failure in this type of equipment.

More analyzer checks have been made on centrifugal pumps than any other type of equipment in our refineries. If a pump gives persistent trouble such as short packing life, seal failures or excessive noise, alignment is checked. If the latter is found correct, the analyzer is put to work.

Recently, a multi-stage hydrocarbon pump developed a persistent vibration. A series of vibration measurements over the driver-pump combination plotted a curve with a "high" over the coupling. The unit was shut down and, after balancing the coupling, the pump was ready to return to satisfactory operation in three hours.

The second largest field for the analyzer is the steam turbine drive, where this instrument is exceptionally valuable for detecting imbalance due to salt deposits before extensive damage can be done.

Compressors

Though there are fewer compressors than pumps and turbines, their higher costs yield the best pay-off for an analyzer.

1. A 300 hp reciprocating air compressor was operating erratically. Prior to shut down the analyzer was brought into play. In three hours it uncovered the defective element, a loose fly-wheel, and the machine was shut down, repaired and returned to operation in eight hours.

2. Excessive vibration developed in a 3000 rpm centrifugal compressor which recycled gas at a reformer. Surveying the turbine-compressor system with the analyzer located the vibrations in the spacer type coupling, and the phase of the imbalance was found with strobe light. Adding a weighted washer at the proper location permitted the unit's return to service in a few hours.

In the absence of the analyzer, one might imagine a situation leading to uncoupling of the turbine, checking and, when finding it vibration-free, shutting down the compressor and dismantling it for a check. The possible shut down time might amount to as much as 40 hours.

An analyzer as described here is a maintenance tool suitable for the rough usage encountered in a refinery, and for operation by personnel at the craft level. Its pay-off will be limited only by the degree of opportunity it is given to eliminate guesswork. Like any other innovation, it has to be fitted into the maintenance pattern. Once this is achieved, the analyzer will be recognized as a valuable tool. ★ ★ ★

INTRODUCING . . . a new series for the REFINING ENGINEER

In the next issue a new series of articles by Kenneth F. Gordon and James A. Davies will be inaugurated. Entitled *Distillation in View of Modern Developments*, it will review both present practices and recent developments in distillation and absorption. This is an outgrowth of an eight-day intensive summer course for industry given last July at the University of Michigan under the general direction of Professor Gordon in which Mr. Davies played a leading role.

The articles in the series will include a short review of basic principles of vapor-liquid separations covering distillation, absorption, and stripping, and will take up in a little more detail the newer developments such as mass transfer theory applications to distillation and tray efficiency, and also tray design, especially perforated trays and comparison with bubble trays. A part will be devoted to such practical topics as instrumentation, design of auxiliary equipment layout, and trouble shooting. The review will be very brief in subjects where adequate articles are available in the literature and are well known. Complete literature references will be given. Batch distillations and packed towers will not be covered.

The series will be broken up into six parts with each part consisting of one or more chapters. Each chapter will be published in a monthly issue of this magazine. Each part will be a self contained entity complete with nomenclature and references.

Lets take a look at the authors . . .

James A. Davies

Professor Gordon

Our authors have two quite different backgrounds. Davies has been associated with the oil industry for 22 years working in refinery and petrochemical design and is chief design engineer for The Texas Company. Professor Gordon's experience includes teaching at MIT and the universities of California and Michigan, two years in industry and various consulting connections during the past seven years. Both have been actively engaged in the AIChE research program on tray efficiencies and distillation columns where Davies is chairman of the Distillation Subcommittee, while Gordon has been associate and acting director of the program at Michigan.

FOR CATALYTIC REFORMING

4 B&W Refractory Castables

with low iron content

B&W Kaocast

Ten years ago, B&W introduced this 3000° castable which offers a combination of high temperature use limit, as well as very low iron content. B&W Kaocast can either be gunned or cast in place.

B&W Kaocrete-LI

After two years of extensive field service, B&W adds Kaocrete-LI to low iron content castables. B&W Kaocrete-LI, which has an iron content of less than 1%, has exceptionally high strength for resistance against abrasion and erosion. It has sufficient refractoriness for use at temperatures to 2700 F. Suitable for both gunning and casting.

B&W Kaolite-LI

Another new castable with over two years of field service, B&W Kaolite-LI has high insulating properties due to its light weight (only 59 pounds per cubic foot). Its iron content is also less than 1%. It is designed to be applied with a cement gun only. Installation and maintenance time can be cut since Kaolite-LI does not require water curing and heat can be applied directly after gunning.

B&W Kaocrete-32

Developed for special high temperature service, B&W Kaocrete-32 has extremely high strength and a use limit of 3200 F. It can be poured, plastered or gunned into place.

Properties of B&W Low Iron Content Castables

		B&W Kaocast	B&W Kaocrete LI	B&W Kaolite LI	B&W Kaocrete 32
Use limit, °F		3000	2700	2300	3200
Melting point, °F		3200	3100	2700	3297
Average density lb/cu ft after firing		126	131	59	134
Average % Fe_2O_3		1.0	0.9	0.8	1.0
Cold crushing strength—psi average—after heating for 5 hrs. at:	1000 F	700	2500	350	1000
	1500 F	500	2500	350	800
	2000 F	400	1200	300	750
	2200 F	500	1300	450	1000
	2400 F	500	1600	—	2000
	2600 F	1000	6000	—	3000
	2800 F	2200	—	—	3500
	3000 F	3500	—	—	4000
	3200 F	—	—	—	5000
Permanent linear shrinkage—average % less than—after heating for 5 hrs. at:	1000 F	0.3	0.2	0.3	0.2
	1500 F	0.3	0.2	0.4	0.2
	2000 F	0.5	0.2	0.4	0.2
	2200 F	0.5	0.2	0.6	0.4
	2400 F	0.5	+0.1	—	0.5
	2600 F	0.5	—	—	0.5
	2800 F	0.5	—	—	0.5
	3000 F	0.3	—	—	0.2
	3200 F	—	—	—	0.1

Consult your B&W Representative for additional information on these and other B&W Refractories for the refining industry.

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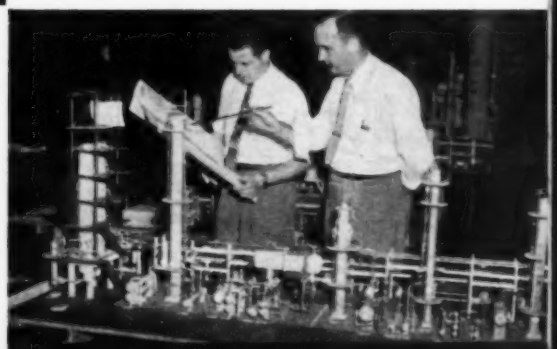
WORLD PETROLEUM CONGRESS and EXPOSITION

WHEN IN NEW YORK for the Congress, refiners interested in advanced engineering and design techniques should plan to see the practical demonstrations of Kellogg's computer-programming and model-building developments. Both can be seen at Kellogg's exhibit at the Coliseum, Booth 510 (second floor, center aisle) or at Kellogg's New York offices.

At the Coliseum, a Burroughs 205 Computer will run three Kellogg programs: (1) Designing a heat exchanger; (2) Computing material balances around a complete gas recovery system; and (3) Calculating streams for the cascade reactor of a Kellogg sulfuric acid alkylation unit.

Also at Booth 510, visitors may watch designers building scale models, see how model photographs are used in place of drawings, and become acquainted with the many ways in which models improve and speed designs.

Refiners wishing to pursue these two techniques further, or to learn about other Kellogg engineering practices, are invited to visit the company's New York headquarters, May 25 to June 5. Arrangements can be made at Kellogg's exhibit or by telephoning Mr. A. L. Dowling, Public Relations, at OX 7-5200.



See scale models being built

See electronic computers at work

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MODERN GASOLINE PLANTS

Part 9: Gasoline Plant Instrumentation

... Control and Relief Valves

... Special Instruments and Equipment

... Examples of Control Systems

Dave Vondy
Constructive Engineering Company, New Orleans, Louisiana

HERE IS continuation of Dave Vondy's discussion covering Instrumentation Fundamentals, with mention of special instruments and control systems. Next month, Part 10, Materials and Equipment, will bring this series to its conclusion.

Motor Valves

Motor or control valves should have adequate capacity for the maximum rate anticipated. Also, it is desirable to use a body that will permit larger trim to be installed, if needed. For good control, the trim should be characterized; that is, the inner valve should be shaped so the flow rate increases gradually as the valve opens over the normal range and increases appreciably as the valve approaches full open position. Many trims are designed for specialty service and are not practical for general service. Both new and replacement trim must be selected with care.

Pressure-balanced valves are required for high capacity service, but are generally limited to low-pressure drop. Spring return valves are most widely used; the spring selected must give smooth operation under required limiting pressure differential conditions and must have long life. The topworks selected must convert pressure change to smooth linear movement and must provide the motive power required to operate the valve under limiting pressure differential conditions and return spring force.

Double port spring valves are used when low-pressure drop is desired. These valves, however, cannot be used when tight shutoff is necessary.

The relationship of pressure drop in the pipe to pressure drop in the valve must be considered in piping design. Appreciable pressure drop must be taken through the valve rather than the piping if the valve is to exercise control.

Install either normally-closed or normally-open valves (choice will depend on use and position of valve) to obtain failure in the best position. Loss of instrument gas is generally the failure condition; thus, valves in relieving or back pressure service should usually fail open for protection. Dump valves on high-pressure equipment should fail closed to avoid gas overloading of downstream equipment... an exception to this would be dump valve failing closed in an absorber, causing loss of the lean oil charge. Here, gas can be relieved by low-pressure equipment.

Low-pressure dump valves should fail open to prevent loss of liquid to the gas. The control valve in an overhead product line may fail closed to avoid product contamination if the tower has adequate auxiliary relieving facilities. Otherwise, the control valve and the bottom product valve should fail open. When possible, an electrically-actuated valve should retain position in the event of power failure.

A three-valve, full by-pass system is required around each control valve if it is to be serviced without shutdown. A typical arrangement is shown in Fig. 51.

Formerly, valve positioners were commonly used to eliminate unsteady valve movement, but in many plants such equipment has been taken out of service. However, it is often necessary to use a valve positioner when a valve is to be operated at low or high temperatures, under a high-pressure differential, or when the flowing stream is to be metered accurately and continuously. Thus, valve positioners are important in obtaining smooth control under unfavorable conditions. In selecting a positioner, it is important to choose one which will operate compatibly with the valve on which it is used.

Relief Devices

Safety devices to relieve high-pressure conditions are quite important. Just because a relief valve is installed on a vessel does not mean, however, that relief requirements are fulfilled. Relief valves are quite expensive and there is a tendency to skimp on size to reduce initial cost. All vessels should have a relief valve sized in accordance with ASME code requirements. Each valve must be tested periodically to insure proper operation.

Many companies prohibit installation of block valves below relief valves. However, proper maintenance can best be given if the relief valves are equipped with an upstream block valve (locked open) to permit repair of the relief unit when required. It is common for a relief valve to leak once it has functioned, thus requiring maintenance.

Burst plates or rupture discs are used in many special instances to provide relieving capacity, but they are not very practical in a continuous process plant due to the complete shutdown requirement. Some designers use undersize relief valves in combination with burst plates, but this practice is not recommended.

Relieving devices should be piped to a safe point. For gas relief it may be satisfactory to install a vertical standpipe to a high point. But, for liquid relief it is best to pipe the stream well out of process and storage areas. There are many situations where it might appear that turning the discharge to point down from the relief valve would be best. This practice, however, is extremely hazardous. Take, for example, such a system for a tank containing low-pressure liquid: If either vented liquid or other hydrocarbons at the

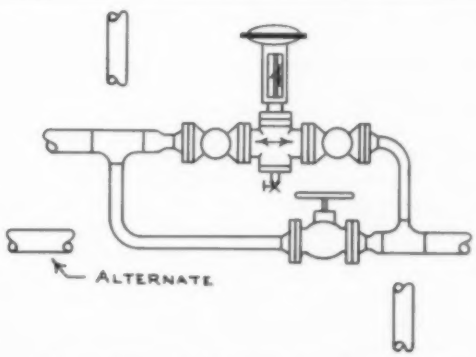


FIG. 51 MOTOR VALVE INSTALLATION

base of the tank catches fire, vapors will be relieved, thus feeding the fire.

Free drainage of water from relief piping systems should be provided in cold areas, lest the lines become plugged with ice. Also, several types of relief valves do not have closed cases and must not be used for services such as relieving liquid downstream from a pump.

Analytical Pressure Instruments

A number of elaborate instruments have been developed to meet measurement and control requirements in situations where relatively simple equipment has proved unsatisfactory.

Dewpoint recorders are used on many pipelines and in large plants where low dewpoint is required for operation. In most situations, however, the high cost of this equipment cannot be justified, simply because the dewpoint is either satisfactory or it is not satisfactory.

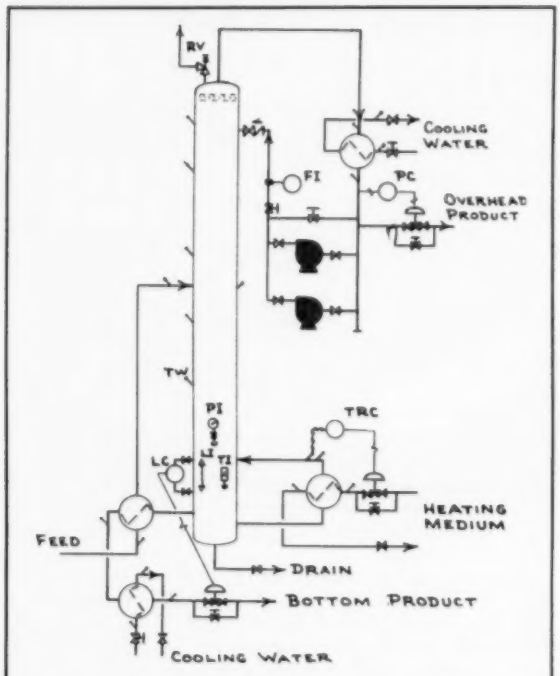


FIG. 52 TOWER CONTROL

H_2S analyzers are used to some extent downstream from desulfurizers. A simple warning device which will report excessive H_2S content may be more practical than an elaborate recording instrument which will shut down a facility when the H_2S content exceeds a safe level. The recording instruments are extremely expensive and require costly maintenance.

The Btu-content controller is particularly useful in a situation where gas is diluted with a low heating-value gas. The controller maintains the heating value near a contract limit.

Continuous vapor pressure recorders or controllers are not yet widely used, but they show considerable potential. A vapor pressure record of one or more of the products would be useful in operation and valuable in troubleshooting. It might prove practical to reset the bottom temperature of a total product de-ethanizer by the vapor pressure of the propane product, for example.

Ph, conductivity, viscosity, density, condensable liquid content, etc., indicators, recorders, and controllers are used in a few specialty applications.

Instruments which determine composition more or less continuously and developments in gas chromatography have produced practical analytical equipment with considerable potential for plant use. Determination of the composition of a gas or liquid stream greatly facilitates operation. Also, elimination of the highly technical operating requirements and lengthy procedures necessary with most of the older equipment has widened the field of practical use of these instruments. Determination of the optimum feed point of a fractionation column, for example, is indeed complex without the use of such equipment. Although this equipment is sometimes used for control purposes, its analytical use is of much greater importance. Purchase of an instrument for a plant can be justified if the instrument is used for allocating products to several feed streams. Processing agreements and similar contacts should provide for acceptance of this method of analysis when practical.

There are many areas where improved instruments are needed. For example, a relatively simple high dewpoint warning device for high-pressure service is needed, as well as a similar instrument which will shut down a facility. Most transmission companies would like to see such an instrument installed at each point of gas receipt, and, if a reliable instrument of this kind were available, might well make its use a requirement under future gas contracts.

Secondary Controls

Secondary controls are widely used to effect safety shutdown, to activate an auxiliary operating scheme in the event of failure of primary controls, or to warn operators of an undesirable or dangerous condition. With the use of these controls, serious hazards can be avoided or reduced. Appreciable loss of product, excessive contamination, or upset of an entire operation can be eliminated. Operator requirements may be reduced.

Secondary controls can be used to eliminate or reduce many undesirable conditions:

- Heaters: High temperature, high stack temperature, pilot light failure
- Engines: High cooling water temperature, high oil temperature, low oil pressure.
- Large mechanical equipment: Excessive vibration, overspeed
- Compressors: High discharge pressure, low suction pressure, high discharge temperature
- Pressure vessels (including tanks): High level, low level
- Fractionation columns: High overhead gas temperature, high level on top tray
- Closed systems (glycol or refrigeration, for example): Low level, high temperature
- Stages of the main process and auxiliary systems: Low pressure, high pressure
- Electrical equipment: High current demand, high temperature

Secondary controls should be checked frequently and regularly to insure their operating when needed.

Auxiliary Equipment

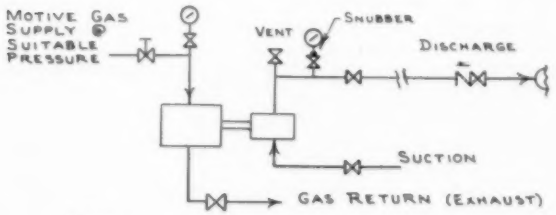
Level indicators should be installed at each point of level control. Usually the best location for a gage is on the external controller body. There are exceptions, however . . . as is the case when the level in the vessel may be different than that in the controller . . . when location on the vessel is better. Also, in low temperature systems that are subject to trouble, level indication in the vessel may be necessary to obtain a true reading.

Reflux level gages are often used for gas-liquid interface indication; transparent gages should be used to show interface between two liquids. A transparent gage is also recommended for any service in which there is a possibility that two liquids will be in the vessel; this will make possible the

determination of a true level, even though the gage shows an incorrect level because one liquid is trapped in it above another liquid. Safety cocks should be used in any application of level indicators. These cocks incorporate check valves which will prevent excessive leakage in the event of glass breakage.

Blowdown should be provided for, so pressure can be relieved from isolated equipment, and foreign material removed. Small blowdown valves should be located inside isolation systems for motor valves, at low points in vapor systems for liquid drain, and at high points of closed vapor systems (such as steam and refrigeration systems) for removal of air or other foreign gas.

Drains are usually installed in each pressure vessel, except when sand, mud, or heavy residue is likely to be present. Syphon-type drains are acceptable, and somewhat more practical from a construction viewpoint than bottom drains.



NOTE:
PROVIDE AUXILIARY RELIEF FROM DISCHARGE LINE WHEN REQUIRED. FOR AUTOMATIC CONTROL, REPLACE MANUAL VALVE IN MOTIVE GAS LINE WITH A THROTTLING MOTOR VALVE.

FIG. 53 PISTON PUMP VALVING

Check valves are used to prevent reverse flow in lines which could upset an operation or produce a hazard. Thus, if instrument gas is taken from two sources, a primary supply and an automatic make-up supply, a check valve should be located in each line so operation would not be interrupted if either supply pressure falls below that necessary for operation. A check valve is often installed in the discharge line from a pump or compressor to avoid sustained high-pressure gas leak if line or equipment failure occurs.

Sampling connections are necessary and preferably should be located upstream from control valves. Do not locate these connections where foreign material might cause poor sampling.

It is often necessary to dry air used in processing so condensed water doesn't cause instrument trouble. Expendable desiccant systems and various methods incorporating a desiccant are often used for drying. In some cases automatic regeneration of the desiccant may be a better method.

Pneumatic leads are made of various materials, usually stainless steel or plastic. High labor costs for installation can be reduced by choosing easily installed equipment.

Instrument Centralization

Instruments are usually centralized in one protected shelter. Development of transmitting devices and of compact instruments has made centralization more practical than local installation.

In a situation where control is critical, local installation of a pneumatic instrument will insure best results. In such cases, remote indication would be better than remote location of the controller. Local installation of heater controls and storage tank level indicators is usually best because the equipment itself is located on a remote site. Here, auxiliary central indication can be provided if desired.

Instruments should be installed so they are easily accessible. For example, a controller should not be mounted near the top of a column or it will seldom receive the attention of the operator.

Maintenance

For reliable, continuous service, follow the manufacturer's service instructions.

Proper lubrication is essential for smooth operation. The wide use of Teflon seals and packing around moving parts has reduced the lubrication problem. Still, care in servicing is necessary . . . a shaft can be scarred (resulting in leakage) by careless servicing.

Regularly scheduled maintenance is always a big factor in reducing downtime. Regular blowdown of level gages will insure proper level indication; regular blowdown of drip pots will prevent accumulation from exceeding capacity. Unfortunately, these typical preventive measures are among those seldom thought of by operators except at time of trouble.

EXAMPLES OF CONTROL SYSTEMS

Tower Reflux System Control

The installed cost of a reflux accumulator in a totally-condensed product line (usually about $2000) is seldom practical. The elaborate controls sometimes used in a tower overhead product and reflux system (ratio flow controllers, partial condensing systems, etc.) are usually too expensive, do not significantly improve operation, and often lead to operating difficulties.

Excellent control can usually be obtained by placing a motor valve in the liquid product line and using a relatively simple, but sensitive controller.

When reserve reflux is needed, a simple storage system with weir overflow or combination weir and drain can be built in the top of the tower.

More elaborate schemes may be necessary in some situations. For example, control of the top temperature in a column would require a complex scheme. In this case, the reflux pump should be one which would not give trouble if vapor should reach it.

Engine Control

In controlling an engine, one of the most important considerations is to avoid sudden overload. Operation at constant speed or at least with gradual change in speed reduces maintenance. Because of this, engine speed is maintained by a governor in many services. Operation at a speed near the maximum recommended for continuous service provides near-maximum horsepower output on demand; available horsepower output falls off considerably when the speed is reduced. Torque control can be used to advantage when operating load varies considerably.

Compressor Control

If a compressor is discharging gas at a certain pressure when it is placed onstream, the suction pressure will decrease (if the compressor will handle all the gas) until the compressor cylinders are fully loaded. Controlling the speed of the compressor from the suction pressure will reduce power consumption in this instance.

When load changes are frequent and sudden, the facility should be operated at near-maximum rating to provide maximum capacity on demand. When several loads are handled by a single unit equipped with a number of compression cylinders, it is usually best to operate at constant speed.

Manually-adjustable or automatic valve lifters and restrictors to clearance pockets are used for control in special situations. Clearance pockets are often useful, particularly on multi-service units, for adjustment of loads.

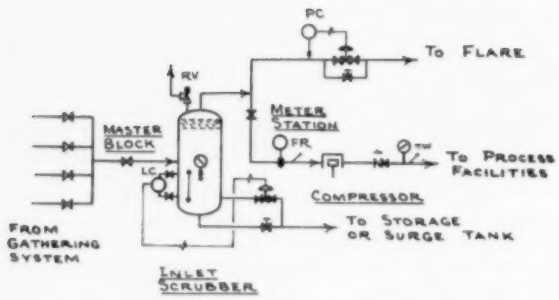


Fig. 54 Low Pressure Gas Supply

Pump Control

Power consumption of a pump may be reduced appreciably by simply placing the control valve in the suction rather than the discharge line. If this is done, care must be taken that NPSH requirements are met, that the pump will not lose prime, and that the pump will handle a partially vaporized stream without excessive rate fluctuation. A typical control scheme for a steam or gas-driven pump is illustrated in Fig. 53.

Generator Control

Generators are normally operated at a speed held constant by governor control of engine drivers. Automatic voltage regulation gives constant voltage. The voltage regulator for small generators should be built in as a component part of the generator. Relatively simple, automatic sychronization is required for smooth change from an operating generator to a standby. Cross-current compensation, controlled in part by engine governors, is necessary for distribution of load between two generators.

Motor Control

The primary disadvantage of alternating current is that the speed of motors cannot be readily adjusted automatically because the cost of electrical-control facilities usually prohibits their use. However, it is sometimes practical to use a two or three-speed system for flexibility and power consumption reduction.

Electric motors are usually operated at constant speed and connected to a power line containing only the necessary starting facilities and circuit breakers. When overload occurs, the motor attempts to draw excessive current from the line; thus, an individual overload breaker should be used for each device. Cross-the-line starting (at full line voltage) is necessary when high starting torque is required. When starting loads are low, reduced voltage starters are used to reduce starting power demand. High starting kva load is critical for major loads. This is particularly true when power is generated locally and high load will cause voltage dip . . . possibly resulting in loss of operation of other equipment. ★ ★ ★

UOP Discloses New Refining and Petrochemical Process

A new continuous process for separation of normal paraffins from hydrocarbon mixtures has been disclosed by Universal Oil Products Company.

Tradenamed "Molex," the process is available immediately for commercial license, UOP engineers Dr. D. B. Broughton and D. B. Carson told the Western Petroleum Refiners Association 47th annual meeting at San Antonio, Texas. The process produces cleaner burning, high octane gasoline components and valuable petrochemical sources at moderate cost, they said.

The new process removes low octane normal paraffins from gasoline mixtures by means of molecular sieves, unique crystals that permit some molecules to filter through and block passage of molecules of a different shape. It improves motor fuel quality by removing low octane, straight-chain paraffins from high octane, branched isoparaffins and cyclics. The normal paraffins then can be isomerized for fuel use or converted to intermediate chemicals.

Previously, normal paraffin removal could be accomplished only to a limited extent. Fractionation separation of C_6 and heavier straight chain compounds is too costly and complex for economical gasoline production. The process makes a clean removal of normal paraffins at considerable savings in equipment and operating costs.

"There are occasions when Molex is not competitive with fractionation, other occasions when it is definitely superior, and still other occasions when it will perform a separation impossible by fractionation," Dr. Broughton said. "Qualitively, Molex will consume less utilities than fractionation in any separation of normal paraffins from other hydrocarbons. For more complex separations, the installed cost of Molex also will be lower."

To date, only practical course open to refiners has been to mask the poor quality of normal paraffins with high octane aromatics fuel components. Fractionation is too costly because the concentration of any one normal paraffin in the gasoline mixture is low, although the total normal paraffin content is high.

By removing the low quality normal paraffins, the new process enables refiners to reduce the aromatics content of fuel blends, the engineers pointed out. This is desirable because the high research octane number aromatics burn poorly under some conditions, resulting in a lower motor octane rating, and are a major cause of "rumble" in high compression engines.

In addition to providing more economical high performance automotive fuels, the process will open new petrochemical markets to refiners. Chemicals such as benzene, toluene and xylene will be in greater supply when less aromatics content is required in fuel blends.

Also, the economical separation of normal paraffins will stimulate manufacture of other petrochemicals and better aircraft and missile fuels. Although normal paraffins are poor automotive fuels, they have the highest heat of combustion of any hydrocarbon — ideal properties for jet and rocket fuels.

Abundant supplies of high purity normal paraffins could be the basis of synthesis of aldehydes, alcohols and other straight chain organic chemicals. Normal paraffins also could be a preferred stock for high temperature pyrolysis to make ethylene and other intermediates, since paraffins are easily cracked.

DU PONT *Petroleum Chemicals* NEWS

Number 95 in a Series of Bulletins for the Petroleum Industry

MARCH-APRIL 1959

Du Pont Helps Refiners Set Up Linear Programming

by Herb Bailey

Herbert O. Bailey, one of Du Pont's refinery technologists, and Joseph Testa discuss a linear programming problem as it is being fed into the computer. In just a few minutes the solution will emerge. Done by hand, the problem would have required weeks of time and reams of paper to solve.

Du Pont Develops AFA-1 for Aviation Gasoline

A new additive (AFA-1) is now being offered by Du Pont as a corrosion inhibitor for aviation gasoline. Since low dosages of AFA-1 are effective, it offers refiners opportunities for substantial savings in corrosion inhibitor costs. Another advantage of the low dosage is that the water tolerance test on aviation gasoline is more easily passed.

For details on this product and its use, call your Du Pont representative at the nearest Petroleum Chemicals Sales Office.

In today's highly competitive petroleum industry, maximum economy in all phases of operation has practically become a management "must."

An important tool in effecting economies is linear programming.

Linear programming, through the use of electronic computers, makes it easily possible to determine the economic effect of all known processing and blending variables in the production of gasoline. In this way human errors arising from prejudgment are minimized.

In order to help the refining industry take fuller advantage of the economy and efficiency offered by the use of linear programming, the Du Pont Petroleum Chemicals Division now offers a new technical service.

This service consists of helping refiners to organize the vital variables of processing and blending in such a way that modern calculation methods can

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DUPONT *Petroleum Chemicals* NEWS

CONTINUED *Linear programming*

be used to get an integrated analysis of all gasoline manufacturing operations.

The DuPont refinery technologists have completed numerous linear programmed studies of gasoline blending economics for customers. Operating variables and incremental manufacturing costs are incorporated in the evaluations.

These studies include such items as: the volume and value of the gasoline components in each blend; optimum reformer severity; the volume of components which should be purchased or sold; the product quality shortage or giveaway on all inspections related to specifications; the loss sustained by diverting components to other grades of gasoline or products through choice or necessity; the range over which the economic variables in a study may shift without changing the recommended blends; and, of course, the economic usage of TEL as an octane control additive.

While such studies obviously cannot always result in major savings, in one instance it was shown that a loss of over $1.00 per barrel was being suffered by diverting one component to a less profitable alternate use. In a second instance, the price being paid for a purchased component was much more than its worth to the user. Such results as these could be determined in an analysis of your own operations.

The men responsible for our linear programming service

JACK S. BELLAH joined the Petroleum Chemicals Division as Refinery Technologist in 1953. He is a graduate chemical engineer from the University of Tennessee. He spent six years at the Socony-Vacuum Oil Company working on petroleum test programs, economic studies, process engineering, and product development. He also worked for Mathieson Alkali Works and at Stanolind Oil and Gas Company in Tulsa, and the Refinery Engineering Company before coming to DuPont.

HERBERT O. BAILEY holds a chemical engineering degree from Rensselaer Polytechnic Institute. Mr. Bailey spent 12 years in the Technical Service Division of Esso Standard Oil Company doing refinery test work, gasoline blending studies, and crude oil and finished product evaluations. He joined DuPont in 1953, starting in sales. Last year he joined the Planning Section in Wilmington as a Refinery Technologist.

New Series–Additives Handling Bulletins

Just a year ago DuPont began a service designed to make the use of petroleum additives as easy and economical as possible for DuPont customers.

It consists of a series of bulletins on special subjects of interest to those who buy additives.

The first bulletin deals with the use of duplex pumps in place of the simplex type for keeping additives free-flowing in cold weather.

Another bulletin covers in detail the knowledge needed for the easiest and most efficient handling of DuPont Rust Preventive No. 2.

These bulletins are written by the men of the "Operations Group." All of them are experienced in the handling of tetraethyl lead and other petroleum additives.

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Du Pont Tetraethyl Lead and other Petroleum Additives

OVER

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

A-10220

Printed in U. S. A.

Technical Computer Applications for the Small Refiner

Proved computer programs now available allow the small refiner to increase profits . . . here is how they will fit into his operations . . .

W. S. Pickrell
International Business Machine Corporation
Houston, Texas

IN THE PAST FOUR YEARS, the petroleum industry has recognized the digital computer as an extremely valuable tool, to the extent that by January 1958, 76 medium-size computers and 8 large-scale computers were in use in the industry.

Computers are being utilized so extensively because in the late 1940's, engineers found that the accounting departments of their companies had machines to perform elementary arithmetic tasks. The machines were capable of addition, subtraction, multiplication, and division, as were desk calculators, but the business machines performed these tasks at a faster rate and with a great deal more accuracy.

As the engineer learned more about the physical system, he was able to eliminate a number of the simplifying assumptions he had previously made, and was better able to represent its behavior. These resulted in more meaningful answers; while increasing the size of the computing problem. Handling these larger problems at increased speed has been the incentive for the development of the present-day digital computers.

As the sizes of the computing problems increase, they increase not in an additive way, but by multiples. The reason is that expansion of a problem statement usually takes place by adding another variable or studying another parameter. In other words, expansion to a larger problem is by adding an additional degree of freedom. So, if the engineer wishes to study five cases of variation for an additional variable, he may be required to perform five times as many computing operations. Thus, the need for larger and faster computers keeps increasing.

Adapted from a paper presented by the author at the Gulf Coast regional meeting of the Western Petroleum Refiners Association in Houston, 1959. Permission of the WPRA to publish this paper is gratefully acknowledged.

Economic benefits to be gained by the company utilizing digital computers determine whether they will be utilized. Benefits to be gained by the use of computers are best pointed out by discussing, in some detail, the technical applications being performed by computers in the petroleum industry.

Applications

The use of computers in refineries is well in advance of that in other areas of the oil and gas companies. This is probably because refinery problems are better defined than those in other departments. The major problems solved on computers by refinery people fall into three general categories:

1. Economic and optimization studies,
2. Unit process calculations,
3. Process design.

Discussed here are some of the more well-known applications in the area of economic and optimization studies. For those who wish to make a more detailed study of any of these applications, there have been several excellent papers published.[1]

Ultimate goal of all refiners currently studying refinery operations with the computer is to optimize the entire refinery, from feed stock to products. This becomes a formidable task when one considers the interactions of all the economic factors susceptible to optimization. Most refiners find that appreciable savings may be made by studying separately five major economic factors. These factors are:

1. Selection of feed stocks,
2. Selection of operating conditions of the units,
3. Best product spectrum,
4. Optimum product blends,
5. Optimum lead level.

In most instances, these are solved using the mathematical technique of linear programming.

[1] Bonner, J. S., and Moore, J. F., "Refinery Economic Optimization." Presented at the IBM Gas Transmission Seminar, Dallas, Texas, May, 1958.

Bonner, J. S., Moore, J. F., and Pyle, W. L., "Development of a Refinery Simulation Program." Preprint 97, AIChE, New York, New York.

Bonner, J. S., "Plant Simulation . . . A Common Problem with Unusual Requirements." Presented at ACM Meeting, Houston, Texas, June 1957.

Downey, S. L., "Refinery Economic Optimization." Presented at the IBM Petroleum Seminar, San Jose, California, December 1958.

Feed Stocks

Most refiners are faced with a variety of potential crudes and distillates of varying properties and varying prices from which to select their feed slate. While a part of the feed may be fixed, there will be options for incremental feeds. In cases where the company has a wide latitude in selecting its feed stocks, savings of from 5 to 10 cents a bbl have been reported. The initial approach to crude evaluation has usually been to mechanize the normal crude evaluation procedures. A fixed refinery with a fixed yield structure and operating conditions for each of the units is chosen and each crude is evaluated through this processing scheme. Using the computer, a large number of cases may be evaluated in the time available. A more advanced scheme for crude evaluation would be through the use of a linear programming model, so that the entire crude slate could be studied at the same time.

Operating Conditions

The second economic factor listed above, selecting the operating conditions of the units, while obviously important, is most difficult to accomplish. For most of the units in the refinery, the mathematical relationships relating yield to all of the independent variables are extremely complex. Usually, the greatest difficulties encountered arise from the lack of sufficient data, both in

quantity and quality. To optimize this factor, the refiner will usually undertake a program of data collection and reduction, using multiple regression techniques to develop the correlation equations. Then the method of steepest ascent may be used to locate the optimum location on the profit-independent variable surface.

Product Spectrum

Properly, before the target for the operation of the refinery units is set, it is necessary to determine the optimum product spectrum. A modern refinery is capable of varying the distillate-gasoline ratio over a wide range. Also, the same ratio may be achieved with different processing sequences, effecting the fuel oil and light ends. As the demand and price structure of the various fuel product streams fluctuate, the optimum conversion pattern shifts.

Octane vs Yield

The last two factors susceptible to optimization listed above should properly be discussed together as it is seldom that either one of the factors will be studied separately. Most refineries have a number of sources of octane quality; three of these would be TEL addition, catalytic reforming, and catalytic cracking. In determining the optimum lead level, the problem is one of balancing octane improvement costs between processing and TEL addition. In producing higher octane stocks, something must be sacrificed . . . the higher the octane, the smaller the yield.

But gasoline blending is only a part of the picture. Simultaneously blending premium, house brand, aviation, jet fuel, and specification residual fuels requires various amounts and qualities of blend stocks and several different products, each having from one to many specifications. Experience by hand generally leads to a combination that will successfully meet specifications, leading to a blending schedule with which the refinery can live and make a profit. Some people who are unaware of the realities of refinery life have been surprised at how well the blenders or refiners group in a refinery can do this complicated job in what seems to be a short time. The fact remains that by hand methods they are doing well to approach 95 percent of the optimum obtained by computer methods. When a change in market demand, product specification, or refinery operations occurs, it may take several weeks for the blending group to develop their experience and intuition in the new situation to the point previously reached. During this time, it is not uncommon to find losses (compared to optimum blending schedules) of more than $1000 a day.

So, the complete blending problem is an extremely complex one . . . solvable only with the aid of a high-speed digital computer, using linear programming techniques. Savings for the so-called gasoline blending problem can be in the order of two cents per barrel.

These are the five major factors subject to optimization. In practice, it is difficult to separate them to study. Usually, when a linear programming model is set up, it will include at least several of the factors for study. Several of the refiners have been working with models that describe their entire refinery and its operation. These problems soon out-grow the range of the medium-size computers and are amenable only to the large computers.

Study Procedure

Mathematical techniques also figure in economic and optimization studies. The three main categories:

1. Case study procedures,
2. Statistical methods,
3. Operations research.

For the refiner to obtain the best results from his computing program, it is necessary to use all three. Only the last, operations research, will determine the optimum "automatically." The other two operate primarily to supply information and data by which the optimum may be reached by trial and error.

The case study approach does nothing that the economist cannot do by hand, if allowed sufficient time. However, monthly schedules or operating plans must be computed under several different assumptions, and constantly need revision. All of this takes a lot of manpower and the computer allows the economist to compute a large number of alternate cases and revisions in a very short time. One refiner has an extremely complete refinery simulation on a computer, which will schedule the refinery, complete with a solvent plant, in one hour's time.

Statistical methods are used primarily to obtain in the proper form the data to use in any of the other mathematical techniques. As an example, linear blending values for use in a linear programming model are properly obtained using statistics.

Linear Programming

Mentioned throughout is the term "linear programming." This is one of the various mathematical techniques classified as operations research. In simplest terms, it is a procedure for solving a set of simultaneous linear algebraic equations, with more unknowns than equations. Since these conditions imply a large number of combinations of the variables which will satisfy the equations, linear programming is used, which is an orderly procedure of going from one solution to the next until one is reached which will yield the largest profit.

Distillation Calculations

Unit process calculations, the next general category, were the first applications mechanized by refiners. As long as 10 years ago, a long time by computing standards, refiners were doing short-cut and plate-to-plate distillation calculations, heat exchanger design, and other chemical engineering calculations on standard punched card machines.

With the advent of the high-speed digital computer, refiners were able to perform plate-to-plate distillation calculations on a much more routine basis. There are several ways to use available computer programs for distillation calculations. In a typical problem (40 plates, 15 components), the time requirement for solution by plate-to-plate techniques using a desk calculator is given as 183 hours, the total time from assembly of the feed data to the final calculations. For the same problem, using a computer, the time is 6½ hours. This time includes the assembly of the feed data and one hour waiting time to get on the computer. These comparative times . . . one man-month by hand and less than one man-day by computer . . . definitely established the economics of the machine solution versus the hand solution.

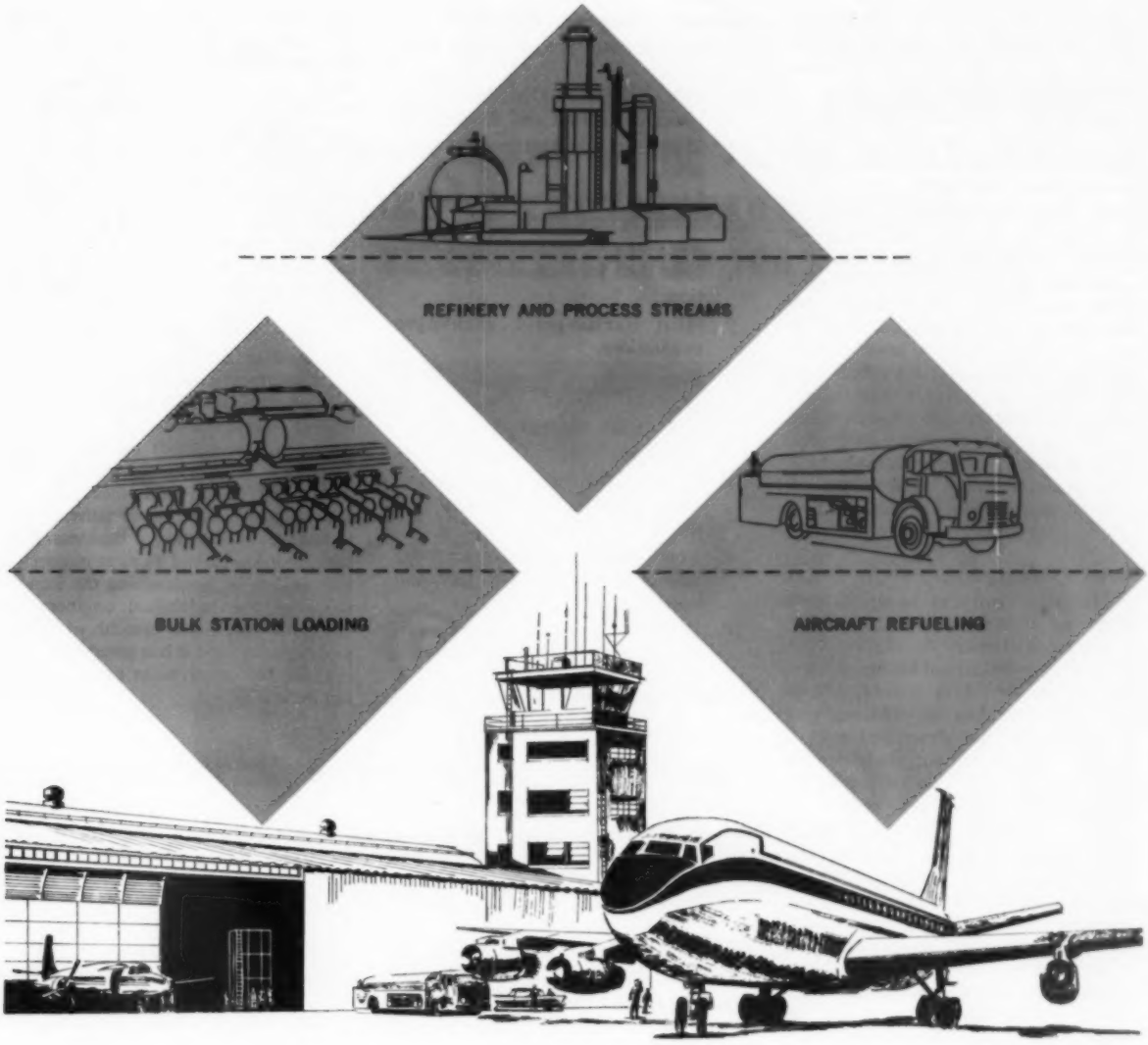
In addition to the obvious efficiency in the use of valuable engineering skills, concrete operating benefits can be obtained from distillation calculations.

Adjustments Facilitated

Refineries must continually adjust operations, investigate new flow patterns and new processes to keep up with competition and changing markets. Crude quality, availability, product quality, and required product split change continuously. These often involve re-routing streams, changing tower feeds, and altering the products from the towers. An easy, accurate analysis of the alternate ways of accomplishing this with existing equipment can result in thousands of dollars a month saved.

Refinery equipment is subject to corrosion and fouling which reduce efficiency of operation. The process is usually gradual and is unconsciously compensated for by higher heat input, higher cooling costs, and loss of product.

A reduction of five percent in recovered solvent from a given feed stock can reach all the way back to an unnecessarily high crude rate and a surplus of fuel oil produced to get the



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solvent. A solvent rate of 1000 bbl per day could require the purchase of 500 bbl per day of additional crude whose profitability is zero or less.

An accurate analysis of tower operation would enable the refiner to recognize loss in efficiency, evaluate changes in operation, and make sound decisions. These benefits are in addition to the reduction in operating costs with efficient operations.

Another use for the distillation programs may be for tower design. The short-cut distillation program may be used for first guess of a tower design, studying such things as the reflux-stage relationship for various separations. Once a preliminary design has been set, a rigorous plate-to-plate distillation calculation may be done to evaluate it. This approach would result in a minimum amount of machine time to firm up the final design.

Heat Exchange

The next process computations which we want to discuss are heat exchanger calculations. A number of refiners realize that a heat exchanger program on the digital computer can be an aid to them in their maintenance program. One refiner developed such a heat exchanger program, studying only the exchangers on one of the major units in his refinery.

The exchangers were on a six to eight months cleaning cycle. However, with the use of the exchanger evaluation program, the refiner showed that reducing the cleaning cycle to three months would result in approximately a $40,000 a year savings over and above the increased maintenance costs. These savings are real and can be found for a number of exchangers in a refinery.

Process Design

Use of the distillation programs for column design has been mentioned above. Probably the most used program for refiner design work is for pipe stress analysis. Most new piping going into refineries and power plants today is analyzed for stresses, using a computer. The savings here can be two-fold: (1) A savings in the actual pipe installed and (2) in the engineering man-hours for the computations. Savings in pipe will result because the short-cut hand methods are necessarily conservative. As to the engineering man-hours, a typical problem which takes two man-weeks by hand may be solved in 15 minutes on the computer.

Also a number of design problems are being solved, using digital computers, by engineering construction firms.

Refinery Program Package

Some computer programs and their uses are:

1. Plate-to-Plate Distillation . . . tower evaluation and design,
2. Short-Cut Distillation . . . tower design,
3. Linear Programming . . . economic optimization,
4. Regression Analysis . . . correlated data for economic optimization,
5. Heat Exchanger . . . exchanger evaluations,
6. Benedict-Webb-Ruben Equation of State . . . process studies,
7. Pipe Stress Analysis . . . analyzing piping systems,
8. Process Engineering Interpretive Coding System . . . case study refinery simulation,
9. For Transit . . . a programming system useful for any technical computation,
10. SOAP II . . . a programming system useful for any type problem, accounting or engineering.

These are a few computer applications in the oil and gas industry which are receiving the most attention. A number of refining companies are making increased profits through the use of computers. Companies that do not have computing programs can also enjoy these profits much easier than those already in computing, by using packaged programs. Also, by taking advantage of the knowledge developed by the consultants in the field . . . developed while serving their clients . . . they may move ahead at an accelerated pace.

Present achievements are only on the threshold of really significant advances in technology and operations. These will come about through the application of operations research techniques to the management of the oil and gas companies. Only with the advent of the high-speed digital computers are we able to utilize these new mathematical techniques in running a business. The computer has played its most important role to date in emphasizing the importance of the individual engineer. It has given him a new breadth of ability and capacity, and it has given him time . . . time for creativeness and engineering decision! ★ ★ ★

NGAA 38th Annual Meeting

April 22-24

The Natural Gasoline Association of America will hold its 38th annual convention April 22-24 in Dallas, Texas. Included on the technical meeting schedule are the following:

Wednesday, April 22, 2 P.M. — Forums

"Dollars and Sense in Manpower Appraisal," developed by M. F. Wirges, Arkansas Fuel Oil Corp.

"Equilibrium Ratios" and "Computer Applications," developed by NGAA Equilibrium Ratio Committee. Karl H. Hachmuth, Phillips Petroleum Company, chairman.

"Development of Vapor-Liquid Equilibrium Ratios for Hydrocarbons," Prof. Wayne C. Edmister, Oklahoma State University.

"Hydrocarbon 'K' Data by Chromatography," S. T. Preston, Podbielniak, Inc.

"Machine Computation of Convergence Pressures," by Dr. Elliott I. Organick, University of Houston.

"Distillation Calculations on IBM 650 Using NGAA 'K' Data," Prof. R. N. Maddox and J. Erbar, Oklahoma State University.

"Use of NGAA 'K' Data on a Datatron Program," Fluor Corp.

Thursday, 9:30 A.M., April 23

"Avoiding Plant Headaches," developed by Frank Stone, LaGloria Oil & Gas Company, and C. A. Schwartz, Caska Corp. Chairman for the forum will be C. T. Wells Jr., Goliad Corp.

"Waste Water Disposal," W. T. Ballard, LaGloria Oil & Gas Company.

"Chromatography for Plant Control," Maynard Perry, Consolidated Electrodynamics Corp.

"Advances in Engine-Compressor Performance Testing," T. L. Novasad, Tennessee Gas Transmission Company, and Fred McNall, Clark Bros. Co.

"Preventive Maintenance," R. H. Illingworth, Magnolia Petroleum Company.

"Economics of Processing Small Gas Streams," developed by Max L. Riley, Southwest Gas Producing Company, and J. W. Ferguson, Continental Oil Company. Riley will serve as chairman.

"Adsorption," Fred Plitt, Southwest Gas Producing Co.

"Refrigeration," M. H. Rahmes, Pan American Petroleum Corp.

"Absorption and Refrigeration," R. I. West, Ginther Gasoline Plants.

Friday, 9:30 A.M., April 24

"Making High-Quality Gasoline with Iso-Paraffins," Nellson R. Adams and D. H. Belden, Universal Oil Products Co.

"Propylene in Propane Motor Fuel," T. W. Legatski, Phillips Petroleum Co.

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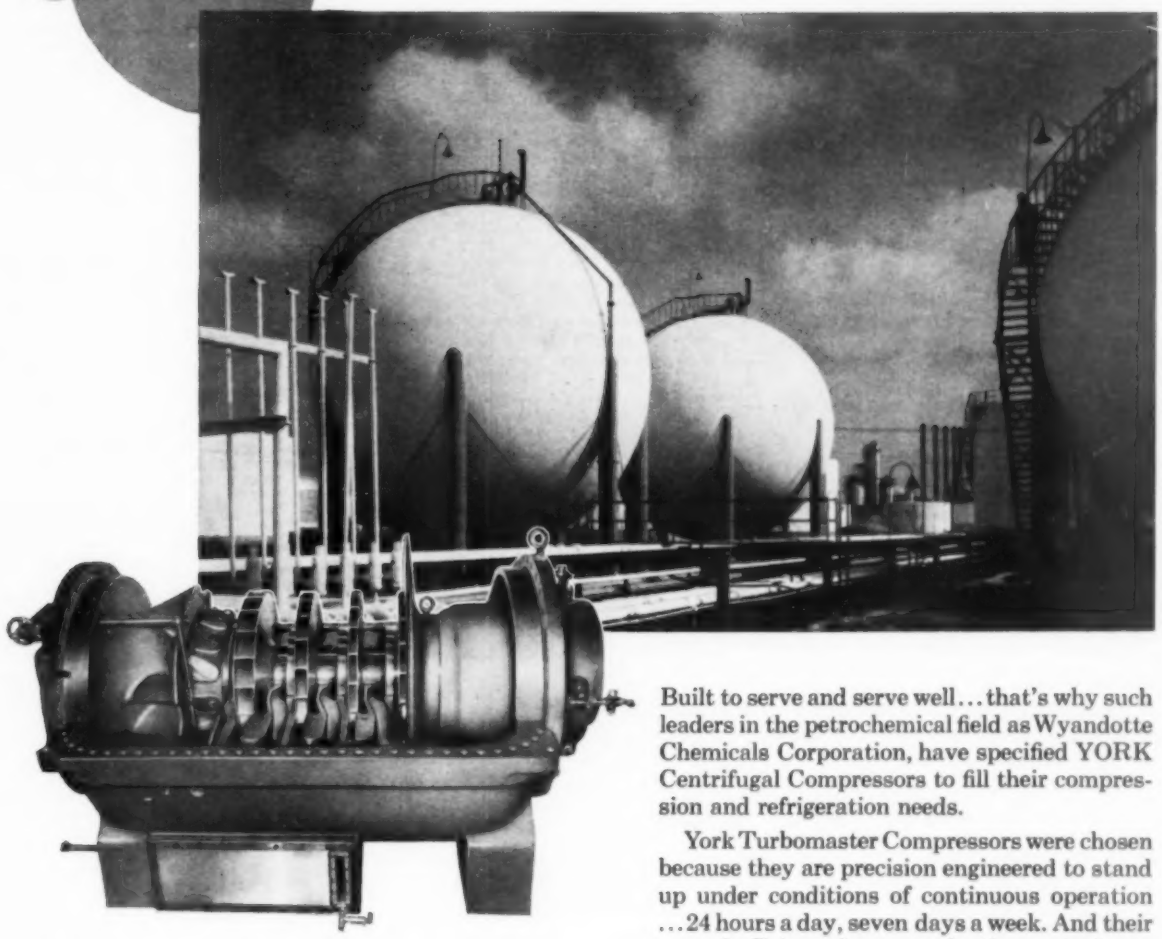

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Refining Books to Read

Plant Operations Test Manual, *compiled and published by Natural Gasoline Association of America, 421 Kennedy Building, Tulsa 3, Oklahoma. Pages 192.*

This book provides a single source for over 80 test methods widely used in gas processing plants. These test methods will be under constant review, and book holders will automatically receive future revisions, and additions as required by changes in methods or plant needs. Manual is bound in waterproof loose leaf binder.

High Speed Math, *by Lester Meyers, published by D. Van Nostrand Company, Inc., 120 Alexander Street, Princeton, New Jersey. Pages 554. Price $6.95.*

Short cuts and time-saving methods for mathematics are covered in this book. Included are simple mental arithmetic processes as well as various kinds of calculations used in business industry. Many methods described are of value, not only because they employ short cuts, but because, by nature of method, there is less chance of error in calculations.

Epoxy Resins, *by Irving Skiest, published by Reinhold Publishing Corporation, 430 Park Avenue, New York 22, New York. Pages 293. Price $5.50.*

These versatile new materials are described as casting and plotting compounds, adhesives, plasticizers, and explains "how" and "why" of epoxy uses. George Somerville, coatings supervisor for Shell Chemical Company, has written the most complete information ever published on epoxy coatings.

Fundamentals of Pipe Drafting *by Charles H. Thompson, published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, New York. Pages 66. Price $3.50.*

Designed for students familiar with basic skills of mechanical drawing who wish to develop specialized skills in pipe drafting.

Gum Plastics, *by M. S. Thompson, published by Reinhold Publishing Corporation, 430 Park Avenue, New York 22, New York. Pages 193. Price $4.50.*

In the first extensive treatment of rubber-modified plastic resins and their uses, the author describes the advantages of impact-polystyrene, ABS polymers, and impact PVC with regard to product improvement, and shows how certain disadvantages of these materials can be overcome.

Evaluated Weather Data for Cooling Equipment Design, *published by Fluor Products Company, Dept. DEW, Whittier, California. Pages, 83. Price, $35.00.*

Some 10,000,000 summer hourly observations recorded by about 400 U. S. and many foreign weather stations have been condensed and adapted to apply to cooling tower design. Text, table and map forms present the 1 percent, 5 percent and 15 percent design levels of wet bulb temperatures at each weather station. Other values presented include dry bulb temperatures, wind speeds and directions coincident with high wet bulb temperatures, and variations between observing stations. According to the Fluor Products Company, the collection is the most useful ever made of evaluated information on wet bulb temperatures, as they apply to efficient atmospheric cooler equipment design.

Catalysis, Vol. 6, *edited by Paul H. Emmett and published by Reinhold Publishing Corporation, 430 Park Avenue, New York 22, New York. Pages 706. Price $19.50.*

The sixth of a series intended to be the most soundly conceived reference source on the physical chemistry of catalysis and catalytic processing, this volume covers catalytic cracking, isomerization of hydrocarbons, polymerization, polymerization of olefins, alkylation and hydroreforming.

Recommended Practice for Inspection, Repair and Rating of Unfired Pressure Vessels in Service in Petroleum Refineries, *RP 510, published by the American Petroleum Institute, 50 W. 50th Street, New York 20, New York. Pages 20. Price $1.*

Covers inspection, repair, evaluation for continued use and methods for computing maximum allowable working pressure of unfired pressure vessels.

Process Dynamics, *by Donald P. Campbell, published by John Wiley & Sons, 440 Fourth Avenue, New York 16, New York. Pages 316. Price $10.50.*

Study of characteristics of processes under unsteady-state conditions, or in response to periodic disturbances. Provides a sound theoretical foundation for development of instrument and process control systems. Particularly valuable in applying feedback control theory to industrial processes, especially chemical and petroleum operations.

Effect of Surface on the Behavior of Metals, *published for the Institution of Metallurgists by Philosophical Library, Inc., 15 East 40th Street, New York 16, New York. Pages 100. Price $10.*

Compilation of a series of papers prepared and given by leading authorities at the 1957 Refresher Course held by the Institution of Metallurgists. Contributors are Dr. B. L. J. Bailey, Dr. F. T. Barwell, Dr. T. P. Hoar and Dr. R. W. B. Stephens. Important for physicists, chemists and engineers as well as metallurgists.

The Properties of Gases and Liquids, *by Robert C. Reid and Thomas K. Sherwood, published by McGraw Hill Book Company, Inc., 330 West 42nd Street, New York 36, New York. Pages 386. Price $10.*

The latest addition to the Chemical Engineering series is by two members of the Massachusetts Institute of Technology, and is intended to serve the practicing engineer. The authors propose methods for estimation of physical properties of materials, and present a review of various estimation procedures for a limited number of properties of gases and liquids.

Recommended Practice for Calculation of Heat-Tube Thickness in Petroleum Refineries, *RP 530, published by the American Petroleum Institute, 50 W. 50th St., New York 20, New York. Pages 22 of text plus 154 charts. Price $6.*

Procedures for calculating the required wall thickness of petroleum-refinery heater tubes for use at elevated temperatures. Intended for tubes more than 2 in. in outside diameter, limited to designs where heat density exceeds 8000 Btu per sq ft.

New Firm Lists Officers

R. R. Dean, president of the recently-created Tennessee Gas Transmission Company division, Bay Petroleum Company, has announced personnel titles for the new firm. L. L. Leabo, vice president of Bay, is director of refined product sales in the South and Southeast and the Rocky Mountain area.

Marketing operations along the Northeast and Middle Atlantic Seaboard are carried on by Hartol Petroleum Corporation, W. C. Burns, president. George H. Meason, a Bay vice president, directs crude oil refining operations. A. G. Pollard is superintendent of the division's refinery at New Orleans, Louisiana, and R. R. Rankin is in charge of the one at Denver, Colorado.

K. G. Pearce, vice president, is in charge of natural gas processing. Reporting to him are the following superintendents: Clyde P. Brown, gas processing plant near Eagle Lake, Texas; W. L. Coffey, gas processing plant, Agua Dulce, Texas; C. F. Mathis, gas processing plant, Rockport, Texas; T. F. Hayes, fractionating plant, La Porte, Texas.

WPRA Directors Named

At the 47th annual meeting of the Western Petroleum Refiners Association, March 15-18, 1959, in San Antonio, the following new directors were chosen: C. H. Barre, Texas City; R. I. Galland, Dallas; R. P. Hargis, Longview; D. R. Johnson, Houston; E. L. Kent, Wickett; Dan F. Krausse, Big Spring; C. L. Moore, El Paso, and G. F. Wynn, Corpus Christi, all from Texas; B. H. Barnes, Pittsburgh, Pennsylvania; S. D. Breitweiser, Tulsa, Oklahoma; Lloyd Freese, Tulsa; John S. Pfarr, Alma, Michigan; Neal Prichard, Oklahoma City, and Maynard Taxman, Centralia, Illinois.

Re-elected directors of the WPRA were: Robert O. Anderson, Roswell, New Mexico; Earl Baldridge, Fort Worth; W. T. Cravens, Bartlesville; O. C. Johnson, New York City; T. B. Kimball, New York; L. E. Kincannon, Indianapolis; L. L. Leabo, Houston; F. C. Love, Oklahoma City; R. E. Luton, Findlay, Ohio; John F. Lynch, Houston; E. B. McConnell, Cleveland; Bruce H. McCully, Kansas City, Missouri.

W. S. Peeler, New York; L. W. Robbie, Texas City; R. G. Sanders, Beaumont; Fred P. Sewell, Dallas; J. H. Sheehan, El Dorado, Arkansas; E. M. Stone, Denver; W. G. Tierney, Denver; J. W. Vaiden, Tulsa; Everett F. Wells, Ashland, Kentucky, and Leo J. Wilmeth, Amarillo, Texas.

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REFINERY CONSTRUCTION MANUAL

PART 9: Purchasing and Procurement

. . . Utilities Systems and Design

. . . Typical Utilities Requirements

Henry Martyn Noel, *New Canaan, Connecticut*

PROCUREMENT ENGINEERS constitute the second largest division in the usual engineering department. Their work is especially important in that it immediately precedes actual field construction. Delays in procurement can delay construction of the refinery, while equipment ordered too far ahead withdraws the company's capital funds from other income producing investments too soon.

Work of the procurement division covers primarily preparation of requisitions, analysis of bids, review of manufacturers' drawings, writing of supplementary specifications, assistance in final purchases, inspection of equipment, and expediting.

Part of the procurement division's time is spent consulting with other groups and preparing standard specifications.

As soon as needed data is available from the other engineering groups, the procurement division prepares blanket preliminary requisitions for the bulk of the standard piping and structural shapes needed. These requisitions, to be supplemented when definitive drawings are completed, are used to get the fabricators working as soon as possible on items that might otherwise prove to be bottlenecks.

The Procurement Organization

A typical procurement division has certain engineers charged with the preparation of standards and other engineers concerned with subcontracts. Its main divisions, however, are composed of equipment specialists such as:

Combustion — concerned with boilers, burners, cooling towers, furnaces, flue gas generators, refractories, waste heat boilers, and water treating.

Electrical — concerned with lighting, motors, starters, switchgear, transformers, turbogenerators and X-ray equipment.

Instruments — concerned with process instruments, laboratory equipment, air dryers and models.

Mechanical — concerned with air conditioning, sewer separators, compressors, filters, machine tools, mixers, pumps, refrigeration and turbines.

Vessels — concerned with barometric condensers, cyclone separators, gas dryers, pressure vessels and towers, tubulars, steam jets, surface condensers and tankage.

Structural and miscellaneous — concerned with buildings, catalyst and chemicals, construction equipment, fire protection, foundations, insulation, marine equipment, paint, piping, sewers, small tools and structural steel.

Requisitions & Standards

Requisitions are prepared to a large extent following books of standard specifications available in most companies. These standards are kept up to date by constant testing of new types of materials and equipment, and improved designs of old types.

Most large engineering groups maintain materials testing laboratories and special equipment testing facilities. Painting, insulation, alloy steels, refractories and castings are subject to routine tests. Corrosion is under continuous study, as are new type burners and bubble trays for fractionators — to mention just a few items.

In a large organization, there is usually so much testing work in progress that a separate department is maintained to handle it.

Inspection & Expediting

Shop inspection and expediting work is of such magnitude that representatives of large oil and construction companies usually live in manufacturing centers all over the country to take care of the continuous flow of orders through the big shops.

Inspection not only covers physical tests, quality of workmanship and conformity to prescribed dimensions, but also involves scheduling and rescheduling of work in shops as required by the relative urgency of the various orders.

Questions of bonus and penalty for improved or delayed deliveries are handled by the purchasing department. In some cases they will cancel overly-delayed orders.

Expediting is vitally important. Shipments have to be followed from factory to site in ordinary cases, and in times of heavy traffic, special arrangements have to be made.

Where large equipment is to be shipped, i.e. bubble towers, reactors and regenerators, an early decision is made as to how much of the assembly can be made under favorable shop conditions, and how much must be done in the field. This involves the study of transportation facilities.

Lead Times

As mentioned before, equipment which takes a long time to fabricate or obtain should be ordered early enough that awaiting delivery of these items will not bottleneck the entire project.

Unusually long lead times should be avoided when possible to prevent tying up company capital in idle equipment.

Proper lead times must be foreseen and provided for in scheduling and the orders must be placed as often as possible in the proper sequence to fit with the known periods of time required for shop work and transportation.

For example, it is known that switchgear, large complicated vessels and oversize compressors take up to a year to make in times of steel shortage. These orders should be placed early, with fabricating shops known to be dependable in meeting promised delivery dates.

Purchasing departments of all large organizations keep track of lead times for all important items of equipment, as well as for all kinds of standard materials. In times of shortages, this question of lead times must be constantly checked and updated.

Items used by refineries which are not in an easy supply position include alloy valves, large boilers, turbogenerators, transformers, complicated switchgear, special slide or plug or motor operated valves, large special compressors, blowers and pumps.

Delivery on such items as cement, asbestos, magnesia and glass wool insulation is usually uncomplicated except that asbestos is limited in world supply to a few sources. These items are used in an amount of about 10 lb of insulation and six bags of cement per bbl per day of refinery capacity.

Often advance bids are obtained and delivery time for special items ascertained in advance of the project authorization. For large important items, this is sometimes necessary before the preparation of the final estimates.

In many cases, bids are accepted in principle to be followed by definitive manufacturers' drawings which must be made and approved before work can start in the shop. This delay should be taken into account, as it often amounts to a month or two in addition to time spent by the purchasing department in getting bids, the time spent by the procurement engineers analyzing bids, and the time spent by the purchasing department placing the orders subject to drawing approval.

Transportation of Materials

Time used in shipment of materials and equipment is extremely variable, but amounts to a month on the average for any sizable item traveling through several railroad junctions in this country.

For overseas shipments, it is necessary to add about two months for land and ocean transport to clear export licensing regulations, prepare the item for export shipment, coordinate land and sea arrangements, and give due consideration to the possibility of overseas purchasing.

Large fractionating towers are usually shipped domestically in two pieces — each piece on one or two railway flat cars. Sometimes the large diameter vessels cannot be accommodated. In such a case, water transport must be considered. In some cases, oversize towers can be floated and towed long distances by waterways or even across oceans.

Special waterborne cranes of 100 tons capacity or more must sometimes be located for loading and unloading heavy items.

The ingenuity of the expediter and his experience in arranging unusual concessions from transport and civil authorities may save considerable time in transport of equipment.

Procurement "Case History"

Procurement work for an average new refinery covers a period of 16 months; for an average large cat cracker 12 months; for an average large pipe still 8 months. A new 25,000 bbl per day refinery would require about 1200 requisitions, while a cat cracker would need about 300, and a large pipe still needs about 200.

The figures in Table 1 show procurement time in months for a large combination cat cracker and reformer requiring a total of 350 requisitions. Also shown in the table are procurement times for the affiliated light ends and gas facilities and another case for a combination pipe still and cat cracker.

In the case of the combination cat cracker and reformer, the procurement work of requisitioning, inspection and expediting required 27 months, while only 17 months were needed in the case of the combination pipe still and cat cracker.

TABLE 1. Procurement times for typical process units (months).

	Combination Cat Cracker[1]	Light Ends & Gas Unit[2]	Combination Cat Cracker & Pipe Still
Demolition and piling	7	—	—
Furnace	3	4	10
Structural steel	9	8	16
Vessels	11	4	8
Pumps and drivers	5	7	5
Exchangers	6	6	7
Blowers	6	3	3
Piping	15	7	12
Electrical	10	7	17
Instruments	15	11	17
Buildings	6	7	4
Insulation and painting	4	3	8

[1]In combination with a reformer. Use a total of 350 requisitions.
[2]In connection with the combination cat cracker-reformer in first column.

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SINCE 1936

Refining

▸ Promotions and transfers announced by the natural gasoline division of Arkansas Fuel Oil Corporation include: **James E. Beavers,** former superintendent of the East Texas plant, Greggton, is now superintendent of the May gasoline plant to be constructed near Kingsville, Texas; **Owen Jenkins,** assistant superintendent of Panola plant, Carthage, Texas, now superintendent of the East Texas plant; **Clint W. Teller,** formerly plant foreman at the East Texas plant, now plant foreman at Panola; and **Homer B. Brown,** field foreman at East Texas, will retain that position as assistant to Jenkins in plant operations.

▸ New refinery manager of Lake Superior Refining Company, Superior, Wisconsin, is **John M. Brown,** former manager of American Oil Company's El Dorado refinery.

▸ **John E. Walkey** has been named manager of process development by The California Oil Company, succeeding **W. S. Svenson,** who has been transferred to San Francisco.

▸ **Professor Hermann I. Schlesinger** of the University of Chicago has won the American Chemical Society's Priestley Medal for 1959, highest honor in American chemistry. Professor Schlesinger was so honored for "distinguished services to chemistry." He is a leader in research on high energy compounds for jet and rocket fuels, and has carried out basic research studies leading to efficient methods for producing hydrides of boron, aluminum and other metals on a large scale.

▸ The 1958 Frank Newman Speller Award will be made to **Aaron Wachter,** director of research, Shell Development Corporation, in recognition of achievements in corrosion engineering. The National Association of Corrosion Engineers will present the award.

▸ **Professor Karl Dittmer,** former head of the Florida State University department of chemistry, is program administrator of the Petroleum Research Fund, administered by the ACS. His office will be in Washington, the Society's national headquarters. **Dr. Cary R. Wagner,** consultant of Utica, Ohio, will continue as chairman of the 19-member Petroleum Research Fund Advisory Board.

▸ **John F. Kunc** and **Robert M. Thomas** have been appointed senior research associates by the executive committee of Esso Research and Engineering Company. Thomas is co-inventor of butyl rubber, developed at Esso in 1937. Kunc is in charge of exploratory long-range research in fuels.

John H. Beckwith, formerly in charge of a project group, has been made head of the operations research section.

Edward D. Boston has been named assistant director in the chemicals research division.

New employees at Esso include: **Richard Graham Adams,** BS in chemistry, Brown University; **Dr. Warren G. Meinschein,** PhD in organic chemistry, University of Texas; **Marian E. King,** BS degree, Drexel Institute School of Library Science.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Personals

▸ Designated senior scientists by Monsanto Chemical Company are: **Dr. Edward S. Blake,** of Dayton, Ohio; **Dr. David J. Beaver** and **Dr. John R. Van Wazer** of St. Louis; **Dr. I. B. Johns** of Everett, Massachusetts, and **Dr. Lawrence E. Nielsen** of Springfield, Massachusetts. **J. Ralph Alexander** and **Harold T. Gammon** of St. Louis were named senior technologists.

▸ **John T. Pinkston** has been named to the newly-created position of process consultant of United Engineers & Constructors Inc., Philadelphia, Pennsylvania, and will be in charge of process development activity. Previously, Pinkston was manager of process at Catalytic Construction Company, Philadelphia.

J. T. Pinkston

F. H. Moore

▸ **Fred H. Moore** has been named executive vice president of Magnolia Petroleum Company and elected to the board.

L. E. Frensley, comptroller, and **E. J. Wacker Jr.,** assistant vice president, have both been named vice presidents of Magnolia. Magnolia has also named **R. D. Hanley,** vice president and manager of the natural gas department, to direct the petrochemicals department Magnolia plans to create.

▸ **Henry A. Heiss,** formerly manager of American Oil Company's Destrehan refinery, is now manager of the Amoco refinery at El Dorado, Arkansas. Heiss succeeds **J. M. Brown,** who is retiring. Three assistant managers have also been transferred: **R. L. Argus,** from Destrehan to Amoco refinery at Texas City, Texas; **F. K. Webb,** from Texas City to Yorktown, Virginia; and **B. V. Tunnell,** from Yorktown to Texas City. **Edwin S. Chelchowski,** process superintendent at Destrehan, has been appointed operating superintendent at El Dorado.

▸ **Captain Josiah H. Hutton** has been named assistant manager of Sun Oil Company's Marine Department at Marcus Hook, Pennsylvania, succeeding **Heston D. McCray Jr.,** retired.

Also at Sun: **Eugene A. Durden** is now resident auditor of Sun's Latin American Production Division, at Maracaibo, Venezuela.

▸ **W. J. Magers** has been named general superintendent of SunOlin Chemical Company's proposed urea plant, scheduled for completion in late 1959. During plant construction, he will serve as operating consultant to SunOlin's engineering group.

▸ The 1959 ASLE National award will go to **Dr. M. E. Merchant,** senior research physicist for the Cincinnati Milling Machine Company, at the American Society for Lubrication Engineers' April 21 meeting. Awarded in recognition of an outstanding contribution to the field of lubrication, the award is the highest honor bestowed upon an individual by the society.

▸ Esso Standard Oil Company has announced the promotion of **Henry G. Abbott** to manager of the training division, succeeding **E. R. Chappell,** retiring after 36 years' service. **Louis W. Lerda** has been named assistant manager.

▸ The American Chemical Society's Petroleum Research fund has awarded a $12,000 grant to **Dr. David M. Himmelblau,** assistant professor of chemical engineering at The University of Texas. Dr. Himmelblau's project will be a two-year study of the reactions of olefinic gases with sulfuric acid.

▸ **Dr. Abraham Schneider** has been appointed a research scientist in Sun Oil Company's research and development division. **Dr. Raymond Wynkoop,** assistant director of petrochemicals, will succeed Dr. Schneider as manager of basic research.

▸ Recent appointments made by U. S. Industrial Chemicals Company, a division of National Distillers and Chemical Corporation are: **William H. Rader,** Petrothene polyethylene production manager, moving up from assistant; **Richard C. Phelps** is customer service group leader; **Clifford E. Oman** is Tuscola, Illinois, general manager.

W. H. Rader

C. E. Oman

▸ Two top management executives have been promoted by Stone & Webster Engineering Corporation. **Fred W. Argue,** engineering manager and vice president,

F. W. Argue

A. L. Hartridge

has been named executive vice president, and **Alfred L. Hartridge,** treasurer and a vice president, is financial vice president.

▸ **Dr. T. F. Cooke** is the new commercial development manager for the Organic Chemicals Division, American Cyanimid Company. He is coordinator of technical service, market research and market development functions of dye; textile, explosives, mining, and rubber chemicals; intermediate and petrochemical products.

▸ **R. P. Corlew** has been appointed manager of refineries for Richfield Oil Corporation. He succeeds **C. R. McKay,** who has retired after 21 years in that post.

▸ **Warren C. Wilson** has been named product manager for lube oil additives at Esso Standard Oil Company's New York headquarters.

▸ **Robert W. Pressing,** former manager of molecular sieves production and development at Linde Company, has been appointed general manager of the new products department of Linde, a division of Union Carbide Corporation.

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For Complete Information on Items Described Here, Use Enclosed Reply Card.

New Polyethylene

Epolene LV, developed primarily as a modifier for paraffin and an additive for rubber and plastics, has been announced by *Eastman Chemical Products, Inc.*, subsidiary of Eastman Kodak Company. Also recommended as an ingredient in polishes, low-cost Epolene LV has low molecular weight.

Circle number (41) on reply card.

Infrared Analysis

New, low-cost, double-beam infrared instrument is designed for analysis in the infrared spectral region from 12.5 to 25 microns. Four-page brochure describes the operation, accessories, and specifications. Also included are spectra which illustrate the performance of the instrument. *Perkin-Elmer Corporation.*

Circle number (42) on reply card.

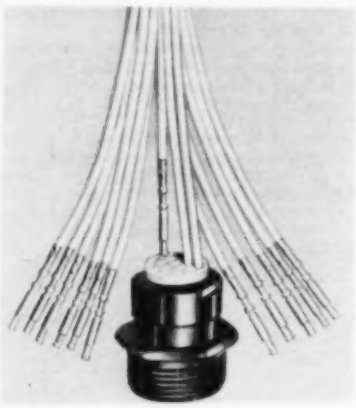
Fuel Filter

Water separation and filtering units to remove water from jet fuel and prevent high-altitude icing in fuel systems have been announced by *Permanent Filter Corporation.*

Circle number (43) on reply card.

Contact Inserts

Push-in inserts which crimp contacts automatically or semi-automatically to wires outside of the connecter, with cross-



holes in each contact to permit ready inspection, is announced by *The Pyle-National Co.*

Circle number (44) on reply card.

Lubricating Cup

Automatic, self-feeding grease cups with visible control are available for plain or anti-friction bearings. Featuring a clear, unbreakable plastic cylinder, the cups allow easy view of grease supply and will replace existing grease fittings, grease cups and other lubricating devices. *Lubriquipment Engineers, Inc.*

Circle number (45) on reply card.

Drum Filler

Output of a manually operated refinery filling station can be tripled by an automatic drum filler, requiring only one attendant. Operating on a continuous basis, the 2-station machine can handle either 55 gal or 30 gal drums, filling more than 1000 50-gal containers in one 8-hour shift. *The Rucker Company.*

Circle number (46) on reply card.

Avgas Additive

AFA-1 Aviation Fuel Additive corrosion inhibitor contains about 5.3 percent phosphorus by weight, has low ash content and is effective in many types of finished products and refinery stocks. Four pounds per 1000 bbl prevents corrosion, according to *Du Pont Company's Petroleum Chemicals Division.*

Circle number (47) on reply card.

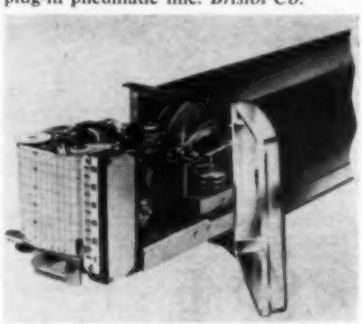
Centrifuge Offered for Testing

A portable centrifuge capable of processing 3000 to 6000 gal per hr is available on a rental basis for production tests and pilot runs. Each unit will be accompanied by a company technician. The CNS-150, largest centrifuge in the Tital line, was designed to fill the need for in-plant, on-stream centrifuge testing. *Pfaudler Co., a division of Pfaudler Permutit Inc.*

Circle number (48) on reply card.

Pneumatic Instruments

All features incorporated in Dynamaster electronic instruments are including in a new series of pneumatic transmitting models, including potentiometers, pyrometers, a-c and d-c bridges and differential transformer receivers. Easily adapted to ratio, cascade and computer-type control systems; convenience of plug-in pneumatic line. *Bristol Co.*



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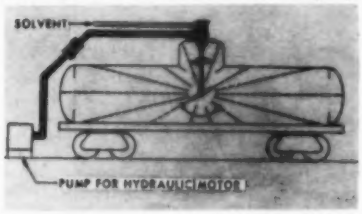
Tank Cleanser

Solvents used in chemically cleaning storage tanks can be applied in high-velocity streams to all internal tank surfaces with a modified version of the "Zingger," announces the *Dowell Division of The Dow Chemical Company.*



The specialized new tool sprays solvents from two nozzles mounted in a revolving jet head which rotates through 360 degrees horizontally and vertically.

Circle number (50) on reply card.

Drum Heat Control

Rapid change from one conventional 55-gal steel drum to another is one feature of Platecoil, a temperature-control device which heats or cools the drums by connection to steam lines, hot or cold water or some other refrigeration source. *Tranter Manufacturing, Inc.*

Circle number (51) on reply card.

Anionic Surfactant

Unusual solubility and stability are claimed for a sulphonated alkyldiphenyl oxide, with good properties as a wetting, dispersing, emulsifying agent and as a detergent, announced by *Dow Chemical Co.*

Circle number (52) on reply card.

Seal Option Offered

Buyers of type C model CA pumps now may choose either a standard Karbate impervious graphite mechanical seal as standard equipment, or a Dura-metallic seal. *National Carbon Co., division of Union Carbide Corp.*

Circle number (53) on reply card.

Boiler Sentry

By reproducing physical and chemical conditions that may exist in a riveted seam or rolled-in tube end, this Embrittlement Detector, Model H indicates tendency of boiler water to cause intercrystalline cracking. *Betz Laboratories, Inc.*

Circle number (54) on reply card.

Fitted Containers

Dome style utility cans for shipping and storing liquid products stack compactly due to a unique top-bottom fitted design. During shipment, a reversible pouring spout is stored inside the can, eliminating the need for reshipping cartons. Hi-Stacker is a product of *Continental Can Company.*

Circle number (56) on reply card.

Chart Typewriter

Standard upper case alphabet figures are combined with 27 different chart symbols on a new typewriter, which makes typing the most complex chart material possible. Made in Germany, the machine is distributed by *Continental Office Machines, Inc.*

Circle number (57) on reply card.

Single Stage Centrifugals

New line of centrifugal compressors is designed specifically for refinery and petrochemical applications. Two types of units are available: One type provides air service at low discharge pressures, and another type handles gas and air applications at higher discharge pressures. *Clark Bros. Co.*

Circle number (58) on reply card.

New Magnetrols

New Magnetrol models combine the functions of two separate controls with only one tank opening, provide two level stages . . . wide differential for control of two pumps, or one pump and high or low alarm. These top-mounting tandem displacement type models are available for flanged or screwed mounting. *Magnetrol, Inc.*

Circle number (59) on reply card.

Plastic Head

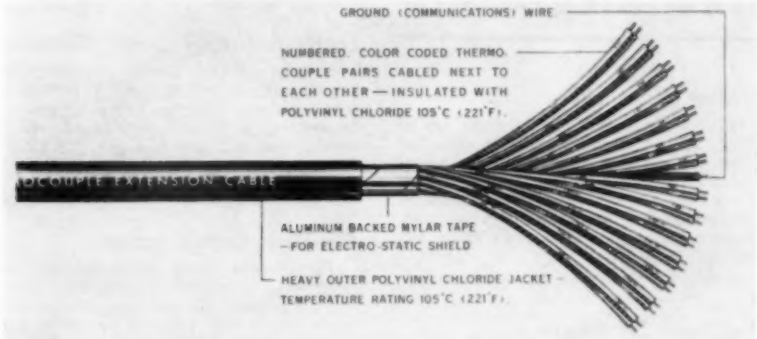
Permanent insulation and support can be given anodes for heat treaters or oil emulsion treaters with a plastic insulating head molded on to give a leakproof connection. *Tejas Plastics Materials Supply Company.*

Circle number (60) on reply card.

Chemical Goggle

Color identification, maximum air circulation and increased protection are features of a yellow framed goggle which can be worn over other glasses without fogging. The Glensite "Softie" chemical goggle is a product of *Glendale Optical Company.*

Circle number (61) on reply card.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NUMBERED, COLOR CODED THERMO-COUPLE PAIRS CABLED NEXT TO EACH OTHER — INSULATED WITH POLYVINYL CHLORIDE 105°C (221°F).
ALUMINUM BACKED MYLAR TAPE — FOR ELECTRO-STATIC SHIELD
HEAVY OUTER POLYVINYL CHLORIDE JACKET — TEMPERATURE RATING 105°C (221°F).

Multi-Conductor Cable

Polyvinyl insulated multi-conductor cable for 6 to 56 pairs of thermocouple conductors is now available from *Thermo Electric Company, Inc.* Because the polyvinyl chloride jacket resists moisture, abrasion, heat and chemical action, the cable can be installed with or without a conduit.

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New Equipment

Organic Inhibitor

Outstanding protection for a wide variety of steel and alloy steels exposed to muriatic acid at 200 to 300 F is claimed for Rodine 220, designed for high-temperature oil well acidizing. *Amchem Products, Inc.*

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No heat freeze. Temp. range -350°F to +2987°F
MEETS GOVERNMENT SPECIFICATIONS
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NO GALLING OR SEIZING recommended for aluminum, stainless, titanium, plastic, steel, brass, etc.
HIGH PRESSURE SEALANT a real thread sealer, pressures held to 50,000 psi hydraulic fluids, 3500 psi air, 1000 psi gases. Has UL approval. For gases, steam, air, ammonia, hydraulic fluids.
CORROSION PROTECTION no corrosion weld, prevents rusting, acid-etch, etc.

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MIL-T-5544	NAVORD OSTD-53
MIL-A-13881	CUSTOM COMPOUNDING

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ARMITE LABORATORIES
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Heavy Duty Pail

Claimed especially resistant to the strongest acids, gasoline, kerosine, jet fuels, chemicals, etc. is a new 18 quart molded-rubber pail made with DuPont Neoprene, announced by *Cauchotex Industries, Inc.*

Circle number (63) on reply card.

Lab Instrument

The most advanced spectroscopic features are incorporated in a double-beam, automatic recording infrared spectrophotometer, designed for precise qualitative and quantative measurement of organic compounds. *Instrument Division of Perkin-Elmer Corp.*

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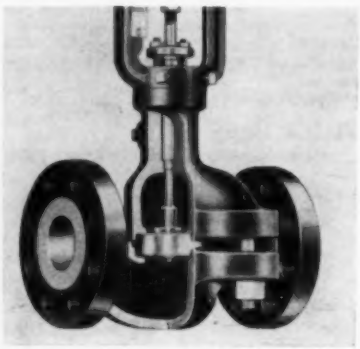
Split-Body Valves

Interchangeability and large flow capacities are the chief features of a complete line of split-body valves for use in high-temperature, high-pressure control applications. Face-to-face dimensions, based on ISA standards, permit complete interchangeability of the split-body line with all other standard makes of diaphragm valves, according to developer *Kieley & Mueller, Inc.* Also, within the line itself, all major components are of unitized construction, making it possible to develop 432 different valve combinations from a single split-body.



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New Literature

Valve Innovation

Forged steel gate valve designs, up to 2-in., which permit complete and fast servicing and testing in the line, are featured in a catalog from the *Velan Valve Corporation.* By allowing replacement of all inner parts without removing the valve, replacement and maintenance costs will be reduced.

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By-Pass Flowmeter

A kinetic manometer type flowmeter that measures by-pass flow as a function of main line flow across a set of orifice taps is described in a specification sheet issued by *Fischer & Porter Company.*

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Catalog of Continuous Stream Analyzers

Eight-page, 2-color catalog describes a complete line of process stream analyzers, including industrial pH equipment, gas chromatographs, infrared analyzers, oxygen analyzers. Abbreviated specifications as well as typical applications of the instruments are included. *Beckman/Scientific and Process Instruments Division.*

Circle number (68) on reply card.

Controller Described

Various controller housing and switching arrangements, covering temperature ranges from —150 to 700 F are listed for the Series 541 Temperature Indicating Controller in a 4-page brochure issued by *Fenwal Inc.*

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Manometer Manual

Principles and terminology encountered in manometry are explained in an 8-page brochure, "Manometers—Theory and Application," issued by *Dynametrics Corporation.* Types of manometers are described, and working diagrams show a number of applications.

Circle number (70) on reply card.

Control Chart

A telescoped circular is available in a revised edition, "Solution to Your Problem of Scale and Corrosion Control." Eleven different Glucosates are shown for their special uses in correcting and controlling scale and corrosion factors; from *D. W. Haering & Company, Inc.*

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Chromatograph Data Sheet

New application data sheet makes easier the selection of columns for analysis of liquids and gases by gas chromatography. Characteristics of 22 chromatographic columns along with their important applications, and 28 chromatograms demonstrating actual column performance are included. *Beckman/Scientific and Process Instruments Division.*

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Nozzle Catalog

Complete listings and data on all types of industrial spray nozzles are given in a 32-page catalog issued by *The Industrial Nozzle Division of Wm. Steinen Manufacturing Company.*

Circle number (73) on reply card.

Large-Capacity Spray Nozzles

Bulletin describes line of spray nozzles for spraying large quantities of liquids at low pressures. Nozzles produce medium to coarse, uniformly distributed, solid-cone sprays with a normal spray angle of 70 deg. and are available in several sizes. *Schutte and Koerting Company.*

Circle number (74) on reply card.

On-Line Computation

Eleven-page brochure completely describes the Bendix G-15 computer and its use for practical on-line computation with a low-cost general purpose computer. The bulletin discusses the G-15's 4 features important in an on-line computer: Speed, reliability, versatility in data transformation and computation, and flexibility of communication. *Bendix Computer, division of Bendix Aviation Corporation.*

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VACUUM FLASH EVAPORATOR

For Continuous Dehydration and Degasification

Designed for removal, under vacuum, of small percentages of volatile liquids or gases from higher boiling point liquids.

Widely employed in continuous lube compounding plants for brightening of lubricating oils.

Available in sizes ranging from bench scale laboratory units to commercial 500 GPM units.

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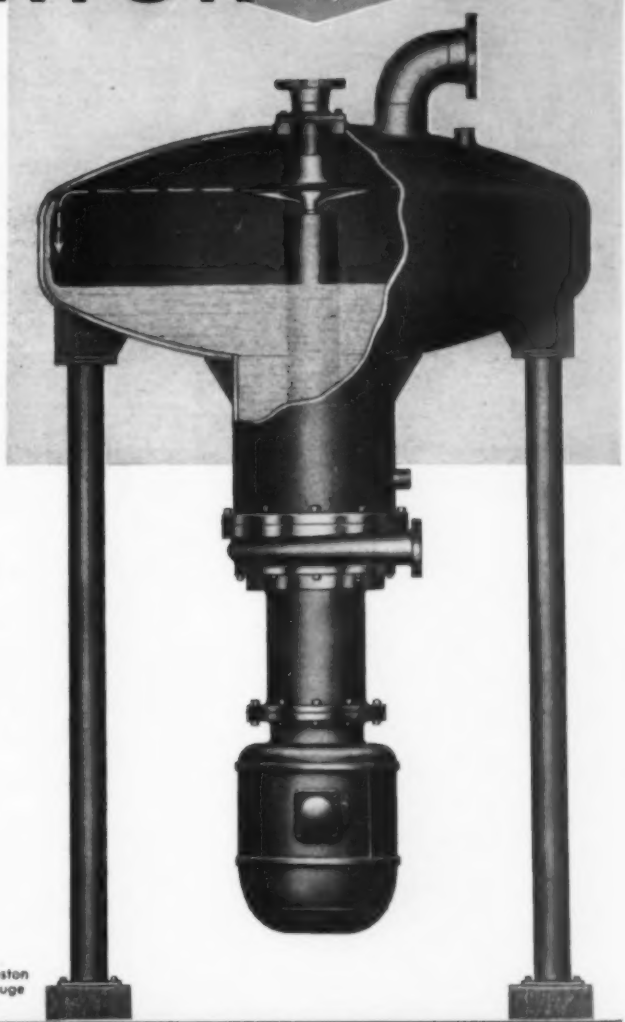

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Charles Wheatley Company
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Worthington Corporation
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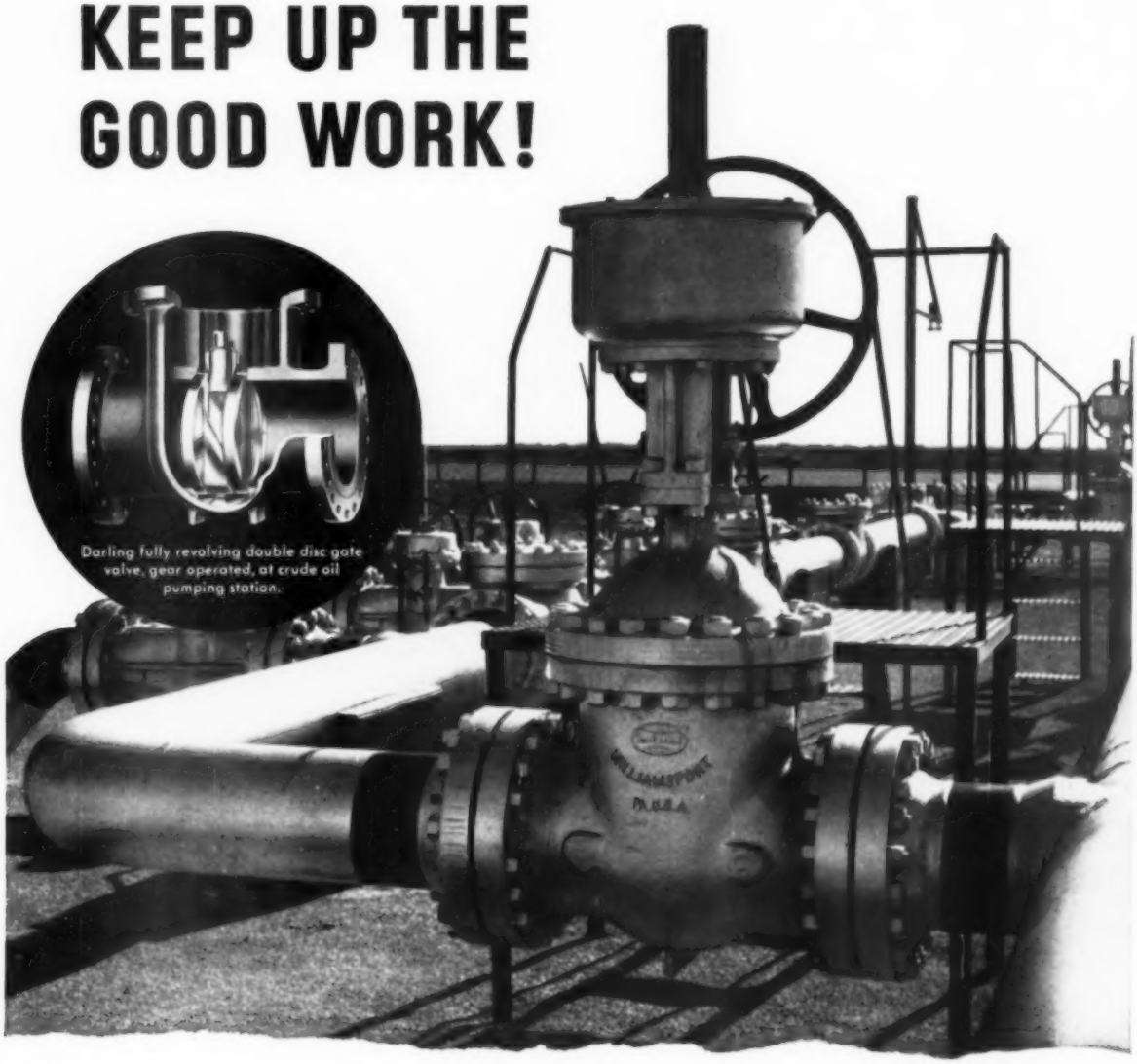
This Darling gate valve feature can help you

KEEP UP THE GOOD WORK!



Darling fully revolving double disc gate valve, gear operated, at crude oil pumping station.

Almost all gate valves start out doing a good job. But it's very doubtful if *any* others can match Darlings for prolonged easy closure and freedom from downtime.

It's largely the Darling *fully revolving double discs with parallel seats* (shown above) that make the difference! This principle minimizes friction and uniformly distributes whatever wear there is. What's more these valves can "live" with the line stresses and surges that cause other valves to fail.

Why not get more familiar with how these Darling valves perform and what they offer you in avoiding trouble and downtime? Simply ask for Catalog No. 57.

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DARLING
VALVES

DARLING VALVE & MANUFACTURING CO.

Williamsport 2, Pa.

Barber-Greene Model 774 Wheel Ditcher—with its many new, exclusive advantages —digs accurately to grade as it sets production records. Write for new bulletin.

Why this rugged Barber-Greene digs up to 25% more trench per day

These exclusive Barber-Greene advantages enable the Model 774 Wheel Ditcher to produce up to 25% more ditch per day than any machine of its size:

- **New Dual Range Hydra-Crowd Transmission** provides infinitely variable crowding speeds independent of wheel and conveyor drives. No stopping to change speeds . . . no gear shifting. Instant selection of maximum crowding speeds for every digging condition.
- **New Flexible Drawbar** between chassis and boom reduces transfer of twist and tilt from wheel to chassis when digging around curves or over uneven ground. Reduces wear and maintenance.
- **New Digging Wheel Drive** through telescoping drive shaft, floating differential and split No. 1 shaft cuts maintenance and wear on drive unit . . . assures balanced torque and constant contact on both sides of the digging wheel.
- **New All-Hydraulic Spoil Conveyor Drive** provides instant selection of infinitely variable speeds up to 630 fpm., independent of wheel speed . . . instant reverse. Spoil placed at desired distance from trench.
- **New Hydraulic Controls** give greatest accuracy in digging to line and grade . . . offer a new high in operating ease. Entire control panel, with all controls in easy reach, results in less fatigue and greater operator comfort.

Other exclusive Barber-Greene features

New crawler design; new automatic electric overload protection; new hydraulic brakes; new hydraulic boom hoist; readily convertible to vertical boom ditcher.

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Write for information on the ditcher line of advanced design.

Barber-Greene BG

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CONVEYORS...LOADERS...DITCHERS...ASPHALT PAVING EQUIPMENT

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LETTERS . . . AND COMMENTS

Handbook Received, Impressed With Data

"We have received your February issue of the PIPELINE ENGINEER, entitled THE PIPELINE HANDBOOK ISSUE. We are most impressed with the information contained, and request one additional copy."

J. E. Flavin, Engineer
Pryde-Flavin Engineering, Ltd.
Consulting Pipeline Engineers
Calgary, Alberta, Canada.

"Best Pipeline Handbook I Have Seen"

"As there are three subscribers to PIPELINE ENGINEER in the office in which I am now working, I do not feel that I need a subscription at the present time. However, I do plan to subscribe to the PIPELINE ENGINEER in the future because I think it is the best publication of its kind in circulation.

"The PIPELINE HANDBOOK ISSUE of February 1959 is the best pipeline handbook that I have seen and I would appreciate it if you would send me one copy and bill me at your convenience."

Zane Wise, Area Engineer
Tennessee Gas Pipeline Company
Agawam, Massachusetts.

Handbook "A Fine Piece of Work."

"The Pipeline Handbook section, which appeared in the 1959 edition of the PIPELINE ENGINEER, is a very fine piece of work. I would like to obtain five reprints of the report. Please let me know the proper procedure."

R. C. Bowden, Jr., Staff Engineer
Research and Technology
National Tube Division, U.S. Steel Corp.
Pittsburgh, Pennsylvania.

Chief Engineer Wants Handbook for Staff

"Would you please send us ten extra copies of the **Handbook Issue** of the PIPELINE ENGINEER? The chief engineer of our company is very interested in this issue and would like to distribute copies to members of his staff."

Trans-Canada Pipe Lines, Ltd.
(Mrs.) P. R. Hutchison, Librarian
Toronto, Ontario, Canada

Four Copies Handbook Requested

"Would you please forward four copies of the February 1959 issue of the PIPELINE ENGINEER?"

C. E. Stewart
The British American Oil Co., Ltd.
Pipe Line Department
Pincher Creek, Alberta, Canada.

Will Present Subscribers Get Handbook?

"We are in receipt of the notice regarding your **Handbook of Pipeline Tables**, a copy of which is being offered free with each new subscription to the PIPELINE ENGINEER.

"As you know, there are presently five subscriptions to your publication being mailed to Mene Grande Oil Company, Pipe Line Department, Barcelona, Venezuela.

"Since the Mene Grande Oil Company has expressed interest in receiving five copies of the manual, we would like to know if they are available to present subscribers."

C. W. Ganster, Assistant Director
Purchasing Department
Gulf Oil Corporation
Pittsburgh, Pennsylvania.

Steel Man Wants Handbook

"I would like to get one copy of your issue for February 1959, designated as *PIPELINE HANDBOOK*. I hope it will be possible for you to forward this by an early mail."

V. M. Randolph
Republic Steel Corporation
Cleveland, Ohio.

Wants Pipeline Handbook

"Please send me one copy of the Feburary 1959 (Handbook) issue of the PIPELINE ENGINEER.

R. S. Caplan, Communications Engineer
Gulf Refining Company
Houston, Texas

How Can I Obtain Pipeline Engineer Handbook?

"We are interested in Handbook Issue of PIPELINE ENGINEER, which, we understand, contains data on pipeline design, corrosion, controls, etc. We understand that you publish this handbook, and would appreciate further information as to its contents, subscription details, and cost."

N. D. Kenney, Engineering Manager
Simplex Wire & Cable Company
Cambridge, Massachusetts.

They Want Copies, Too

"Please send me two copies of the February 1959 issue of PIPELINE ENGINEER, and bill me at that time."

J. W. Nanney
Pioneer Natural Gas Company
Amarillo, Texas.

"Please furnish us with two copies of your publication PIPELINE ENGINEER, February, 1959, edition, Volume 31, No. 2. Please include invoice with copies."

J. G. Floyd, District Manager
Bethlehem Steel Company, Supply Division
Shreveport, Louisiana.

EDITOR'S COMMENT:

The February **Pipeline Handbook Issue** was edited as a special service to readers. We anticipated that *new subscribers* also would like to have this issue. Our prediction was correct, as revealed by typical inquiries here. Almost every new subscriber has expressed an interest in the **Pipeline Handbook,** so the limited supply of extra copies is being reserved (as long as they last) for these new readers.

Subscription rates appear on the contents page. Be sure to state with your order that you want the **Pipeline Handbook Issue.**

Save dollars 4 ways with UNICOR®

1. Maintain flow capacity

Unicor prevents corrosion in pipelines—keeps pipelines free of scale. With Unicor you are assured of maintaining maximum flow capacity, C factor and output.

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Downtime to scrape lines and replace filters is production time lost. Prevent such loss with Unicor. It keeps equipment free of products of corrosion.

3. Cut filter replacements

What's your annual bill to service and replace filters? A pretty penny, no doubt. You can drastically reduce this expense by using Unicor.

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Tanks, vessels and pipelines stand up longer when you give them effective protection against corrosion. A little Unicor goes a long way—protects against corrosion from well to consumer.

Unicor, the preferred oil-soluble corrosion inhibitor, can be added to your product at any point in your operation. Costs less than a tenth of a cent per barrel of product. Write our Products Department for detailed information. Ask about samples and how to test them.

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More Than Forty Years Of Leadership In Petroleum Refining Technology

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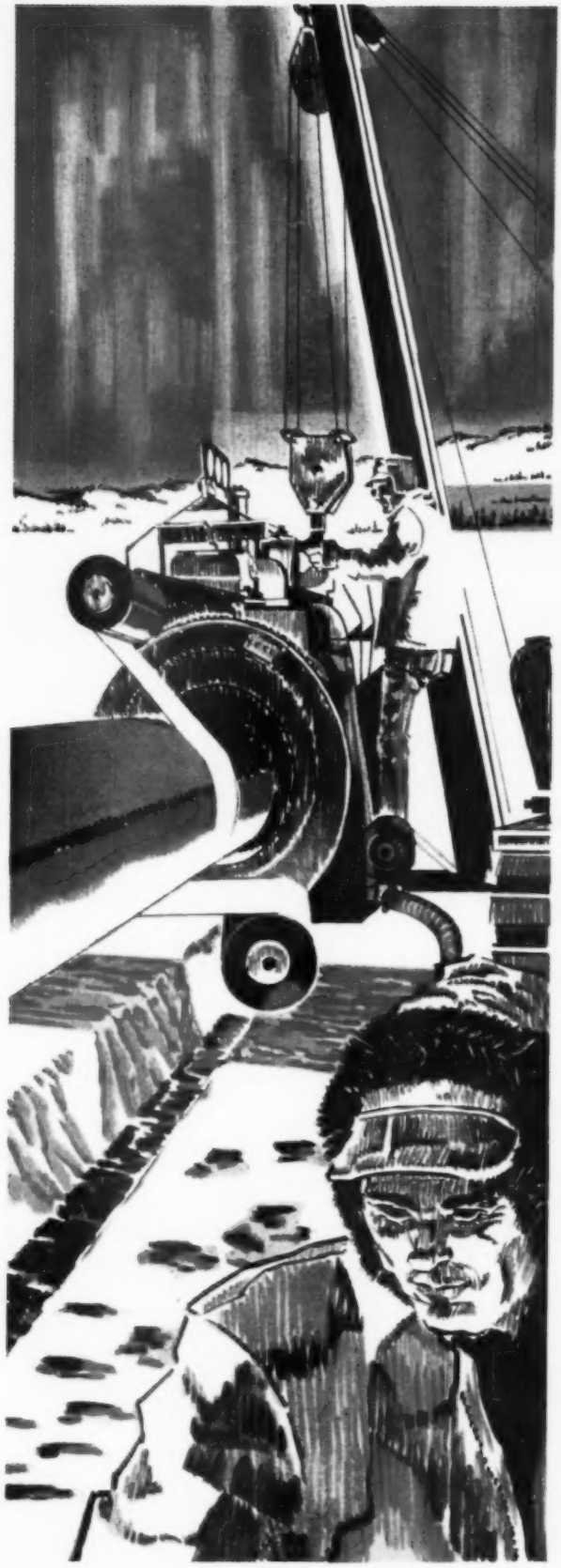

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PIPELINE CONSTRUCTION

EQUIPMENT

...anywhere!

This is the kind of country that brings out the best in men and the rugged Crose equipment they depend upon for pipeline construction work under severest weather conditions. Whether you're line traveling across the cold, barren northlands, or the burning desert sands, you can be sure that Crose equipment has been designed and built for the toughest jobs. Pipeliners the world over have found this to be true.

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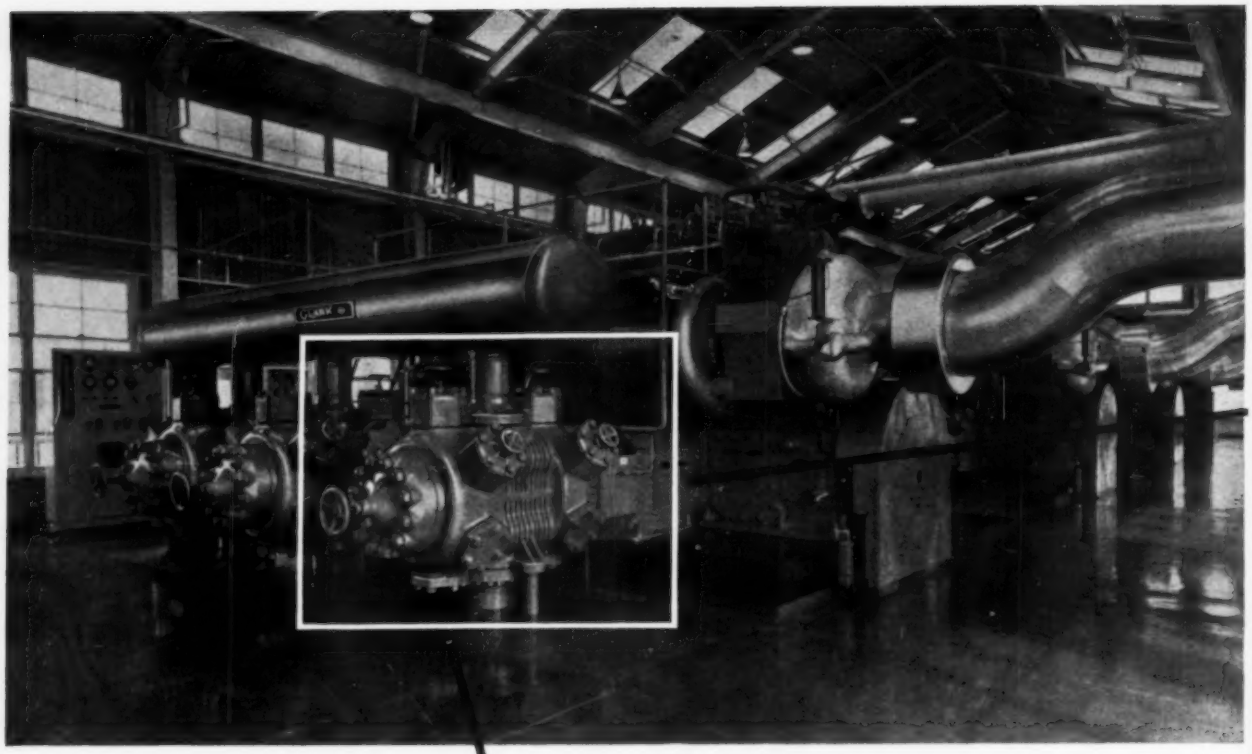
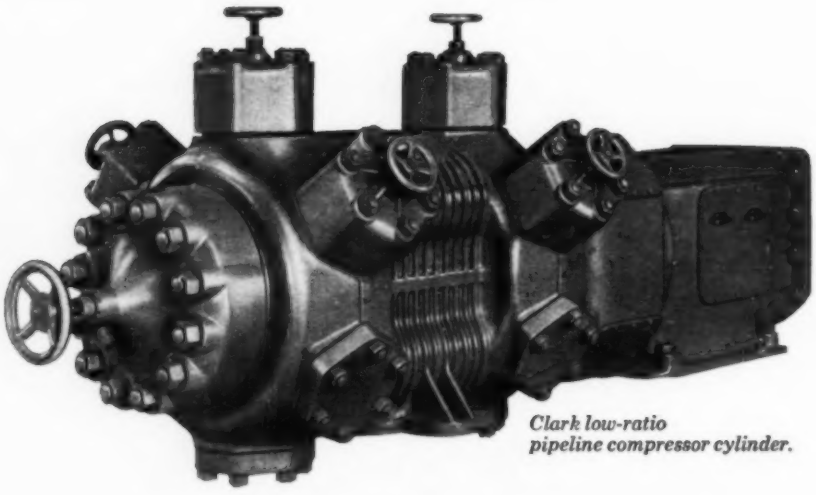


NEW CLARK CYLINDER INCREASES



Clark low-ratio pipeline compressor cylinder.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Clark nylon poppet valve for pipeline application.

AND VALVE DESIGN... COMPRESSOR EFFICIENCY 15%

Unequaled loading flexibility plus optimum compression efficiency at ratios of 1.2 and less...and it is all wrapped up in one compressor.

A newly introduced low ratio compressor cylinder and matching nylon poppet valve now make it possible to install Clark TLA reciprocating compressors in *every* pipeline compressor station with complete assurance that the most efficient compressor ever developed for low ratio pipeline application is on the job. There is no longer any reason to differentiate between primary and intermediate stations . . . the TLA will handle them both with unmatched economy.

The problem faced by designers of reciprocating compressors for low ratio pipeline service has always been that too much of the compressor cylinder's suction stroke has been wasted in drawing a vacuum to open the suction valves. That meant wasted horsepower and reduced capacity.

But this is now completely changed. The light weight poppets of the field proved Clark valve open immediately upon piston reversal. Furthermore they open wide to permit a completely free flow of gas into the cylinder. Extra large, streamlined internal manifolds in the new cylinders and extra large suction and discharge nozzles hold pressure drop through the cylinder to an irreducible minimum. The new nylon poppet Clark valve is so efficient that it is rarely necessary to double deck them.

But efficiency is only part of the story. These new valves are literally maintenance free. Continuous runs of over 30,000 hours have been made without maintenance. Valves have thus been field proved for three and one-half years while the "new" cylinders have been operating for over a year. Your nearest Clark office has the complete facts or write for Bulletin No. 168.

CLARK BROS. CO.
OLEAN, NEW YORK

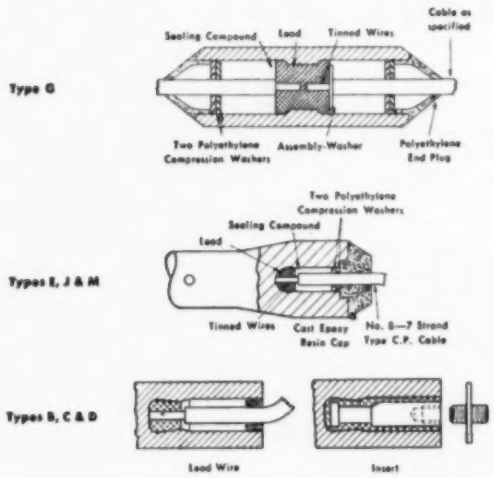
CLARK®

COMPRESSORS • GAS TURBINES

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

DURIRON® IMPRESSED CURRENT ANODES

For more positive cathodic protection of all types of structures used throughout the petroleum industry, insist on DURIRON® ANODES. Duriron performs as well as graphite in all the easy services, and far outperforms graphite when the going gets tough in marshlands, at river crossings, or wherever it is impractical to use backfill. Duriron anodes have proven their superiority for the protection of pipelines, drilling rigs, well casings, storage tanks, and similar structures. For real protection, get Duriron.



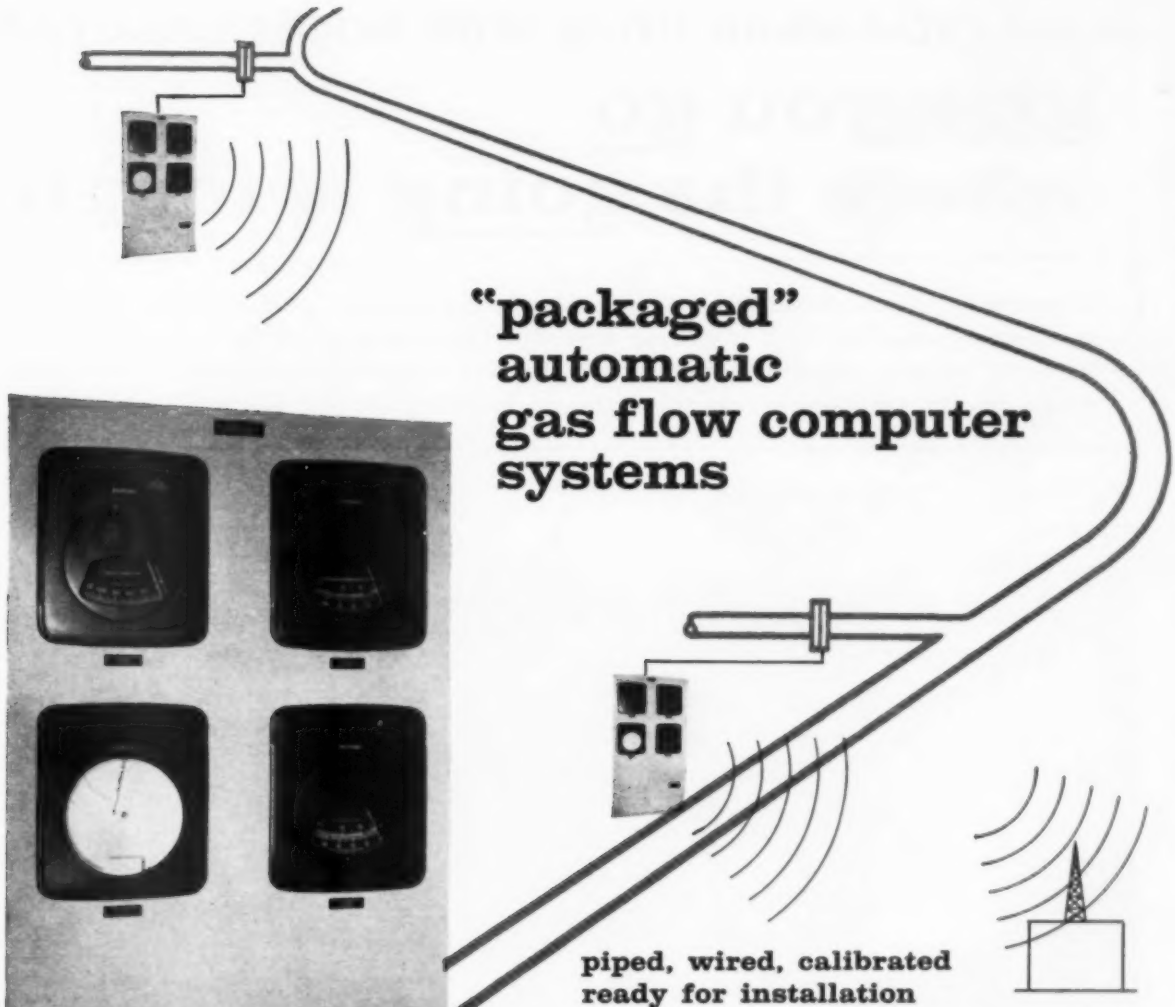
STANDARD ANODE SIZES

Type Anode	Size	Area Sq. Ft.	Weight (Lbs.)	General Application
B	1" x 60"	1.4	14	Fresh Water
C*	1½" x 60"	2.0	25	Ground Bed
D	2" x 60"	2.6	46	Ground Bed
E	3" x 60"	4.0	115	Salt Water
G	2" x 9"	0.4	5	Ducts
J	3" x 36"	2.5	80	Salt Water
M	2" x 60"	2.8	57	Salt Water

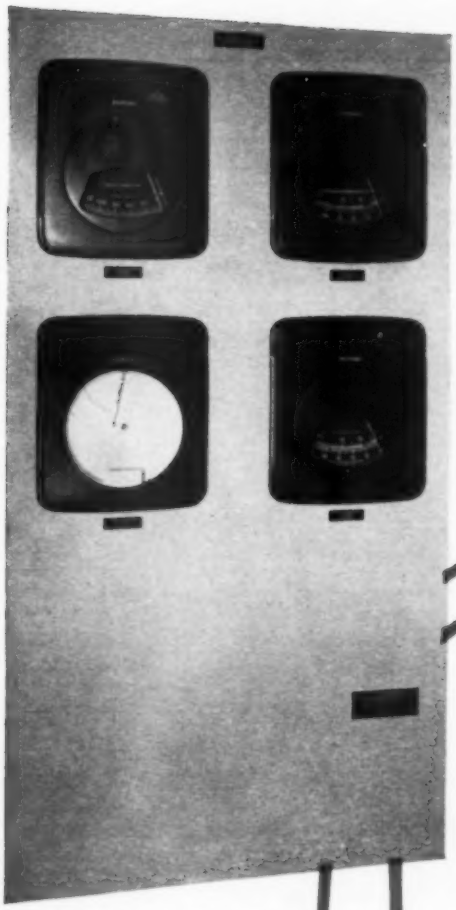
*Applicable also in fresh water service. Should not be used in ground beds without backfill.

THE DURIRON COMPANY, INC. / DAYTON, OHIO

DURCO



"packaged" automatic gas flow computer systems



Typical Foxboro Gas Flow Computer Differential and static pressure instruments (right side of panel) convert measurements to electrical inputs for the Dynalog Computer-Telemeter (lower left). Instrument at (upper left) telemeters down-stream gas pressure.

piped, wired, calibrated ready for installation

A continuous record of gas flow — into or out of your pipelines — that's the information a dispatcher gets automatically with the Foxboro Gas Flow Computer.

Foxboro systems do their computing at the meter station, automatically compensating for gas temperature and pressure, and transmit total flow values. Transmission errors common to systems that compute at the receiving end are eliminated. Transmission line space is saved as well.

Foxboro Gas Flow Computers are furnished as a complete packaged unit — calibrated and tested as a system before shipment. Installation is as simple as setting the panel unit in place — making connections. Computers are available for both single and multiple meter runs.

Ask your local sales engineer about the Foxboro Gas Flow Computer. He can tell you about many installations in successful operation. **The Foxboro Company, 384 Norfolk Street, Foxboro, Mass.**

FOXBORO
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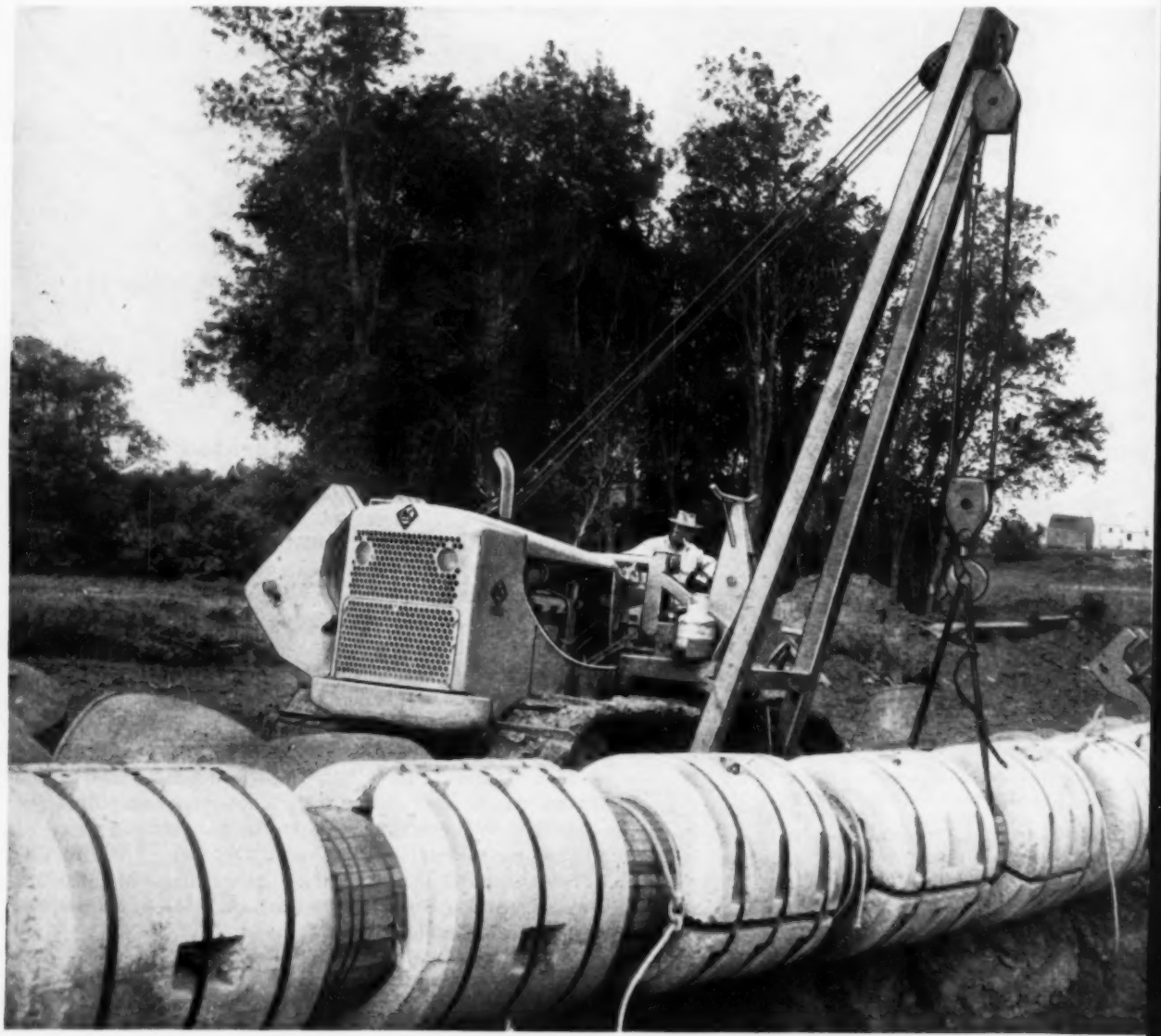
Instrumentation

ALLIS-CHALMERS HD-21 SIDE BOOM TRACTORS

give you go where the going is tough

Whatever the terrain—dust bowls, swamp holes, steep hillsides . . . whatever the pipe—big-inch, super-inch, giant-inch . . . you can depend on Allis-Chalmers HD-21 side boom or dozer units for low-cost, big-output performance. HD-21's measure up to a pipeliner's requirements by any yardstick—capacity; clearance; flotation; day-in, day-out dependability.



...move ahead with ALLIS-CHALMERS and

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

The Allis-Chalmers HD-21 . . . measures up with POWER

Here's power to spare—deep-chested, *usable* power pipeliners can depend on to get the job done—come high water, mud, rocks, 100-percent slopes, any of the tough conditions common in pipeline work. In every Allis-Chalmers tractor, direct electric starting on diesel fuel saves hours of productive time.

Power for the HD-21 pipeline tractor—the new Allis-Chalmers 21000 Turbocharged Diesel Engine with 225 net engine hp at 1825 rpm.

. . . measures up with clearance and flotation

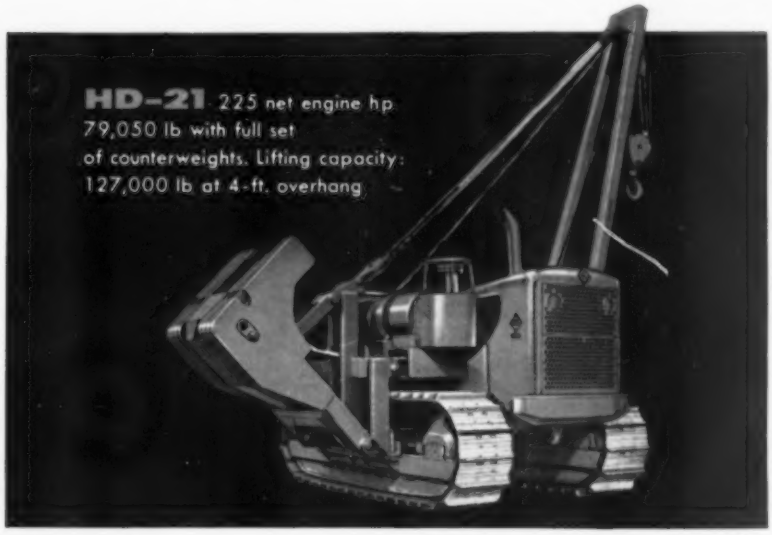
Allis-Chalmers high-clearance pipeline tractors walk right over rough, bumpy ground. Excellent balance and maximum ground contact distribute tractor weight for better flotation and stability—keep the tractor moving even in the softest going.

. . . measures up with unsurpassed smoothness

Hydraulic Torque Converter Drive—pioneered and proved in Allis-Chalmers crawler tractors years ahead of any other make (since 1940)—delivers smooth, cushioned power; automatically matches tractor speed to the load. Operator gives full attention to boom work and signals, never needs to shift. Hydraulic cushioning protects the entire power train and side boom from sudden load shock and strain.

. . . measures up with outstanding control

Tractomotive side booms on Allis-Chalmers pipeline tractors give you safe, sure pipe handling. Controls are positive-acting, mounted in needle bearings for easy operation and ideally arranged for operator convenience. Internal-expanding brakes, completely enclosed for protection from dirt and moisture, control load line and boom line drums. Safety features include drop-proof, counterweight linkage, cable guards, locking winch controls, heavy-duty jaw clutches in winch drum drives.



Now . . . Allis-Chalmers announces PERMA-SAFE lubrication for all models in its crawler tractor line...climaxing more than 20 years of constant research and on-the-job experience with Positive Seal, tapered roller bearing design. Now you can forget about greasing front idlers, support rollers, truck wheels . . . convert that lost time to profit time. Allis-Chalmers certifies that these components were lubricated at the time of assembly and that they need no further greasing . . . regardless of weather or terrain conditions under which they may have to operate. Allis-Chalmers, pioneer of extended lube intervals, lets you take this big step ahead with complete confidence.

Three Allis-Chalmers side boom tractor models give you a choice of sizes and capacities to fit any job. Your Allis-Chalmers dealer will be happy to show you these machines in action. Give him a call right now!

ALLIS-CHALMERS CONSTRUCTION MACHINERY DIVISION
MILWAUKEE 1, WISCONSIN
TRACTOMOTIVE CORPORATION
DEERFIELD, ILLINOIS

TRACTOMOTIVE...power for a growing world

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ADVERTISED PRODUCTS, SEE READER SERVICE CARD

FOR 44 OF OIL'S 100 YEARS

GASO Has Been FIRST in the Favor of Pipe Line Men

44 years ago Gaso introduced a new concept of pump design, based on the principle of fewer parts, made extra-strong.

Pipe line people liked the concept, discovered through experience that it resulted in better performance, less maintenance and longer life, and made Gaso their preferred source of supply.

Gaso has maintained leadership in its field by the simple process of keeping faith with its customers . . . by keeping abreast of their needs and developing models to meet them; by giving them the advantage of every metallurgical and engineering advance that contributes to performance . . . and by building an organization of distributors who bring Gaso pumps, parts and service to the door-step of users throughout the oil country.

May we send our latest catalog?

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Reilly 230 X-1 Primer

QUICKLY

adds extra staying power to hot application fully plasticized enamels

It creates a bond between fully plasticized coal tar enamel and metal that strengthens as it serves... that, when properly applied, increases the reliability factor of the application process on steel pipe and tank surfaces to a comfortable 100%.

Reilly 230 X-1 Primer is

1. Quick drying, 20 minutes ± in clean atmosphere at 70°F.
2. Non-sagging and non-curtaining.
3. Economical to use (750 to 1400 sq. ft. gal. coverage).
4. Derived wholly from coal tar materials.
5. Acceptable to A.W.W.A. and government standards.

Specify REILLY 230 A. W. W. A. enamel with 230 X-1 primer. Also, soon to come, HS X-1 for Hot Service and QD-X-1 for Intermediate enamel.

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11 So. Meridian Street
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Reilly COAL TAR PRODUCTS
ARMEX Protective Coatings

Teletype in pipeline operation . . .

A flexible, integrated system for

ACCOUNTING. Since some of the information transmitted within the communications system can be utilized in accounting, such data is channeled to the accounting department, either by direct transmission from the field station or tape received in the communications center.

The accounting department is equipped with Model 28 Tape Punch and Tape Reader . . . also, 600-word-per-minute Teletype High Speed Tape Punch and Reader to utilize by-product tapes for operation with business machines and computers.

COMMUNICATIONS. The communications center may be equipped with Teletype Model 28 Page Printers, Tape Readers and Tape Punches—or Model 28 ASR Automatic Send-Receive Sets. Signal medium to the center may be metallic pair, telephone circuit, radio . . . including microwave.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

telemetering, communications, accounting

Teletype equipment makes possible a unique approach to data handling, communications, and control in pipeline operation. The new 100-word-per-minute Model 28 Line will provide continuous operational data . . . handle administrative traffic . . . and, as a by-product, supply information for accounting needs—all at high speed and surprisingly low cost.

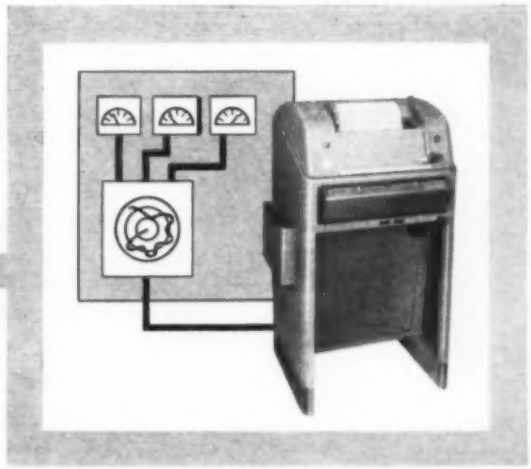
The Teletype Model 28 Line provides exceedingly flexible combinations of units for sending, receiving, and recording information, as well as for remote control of equipment. Input may be manual keyboarding, punched tape or electrical signal; output may be page copy, punched printed tape, or contact operation for remote control.

Sub-station printers may be unattended—yet administrative traffic can be channeled to these stations . . . data gathered from them . . . and pumps, motors, compressors, generators, etc., controlled. Printed records and tape can serve for evaluation, control, and integration with business machines and computers.

The picture sequence shown here illustrates a variety of Teletype units which may be used in pipeline operations. Model 28 equipment was designed specifically for the kind of continuous service demanded in pipeline work. It is reliable, rugged, needs little maintenance—making it ideal for unattended service. Its ability to perform a wide variety of functions means savings now and in the future, as your needs expand. For more information about the equipment here described, write: Teletype Corporation, Dept. 90D, 4100 Fullerton Ave., Chicago 39, Illinois.

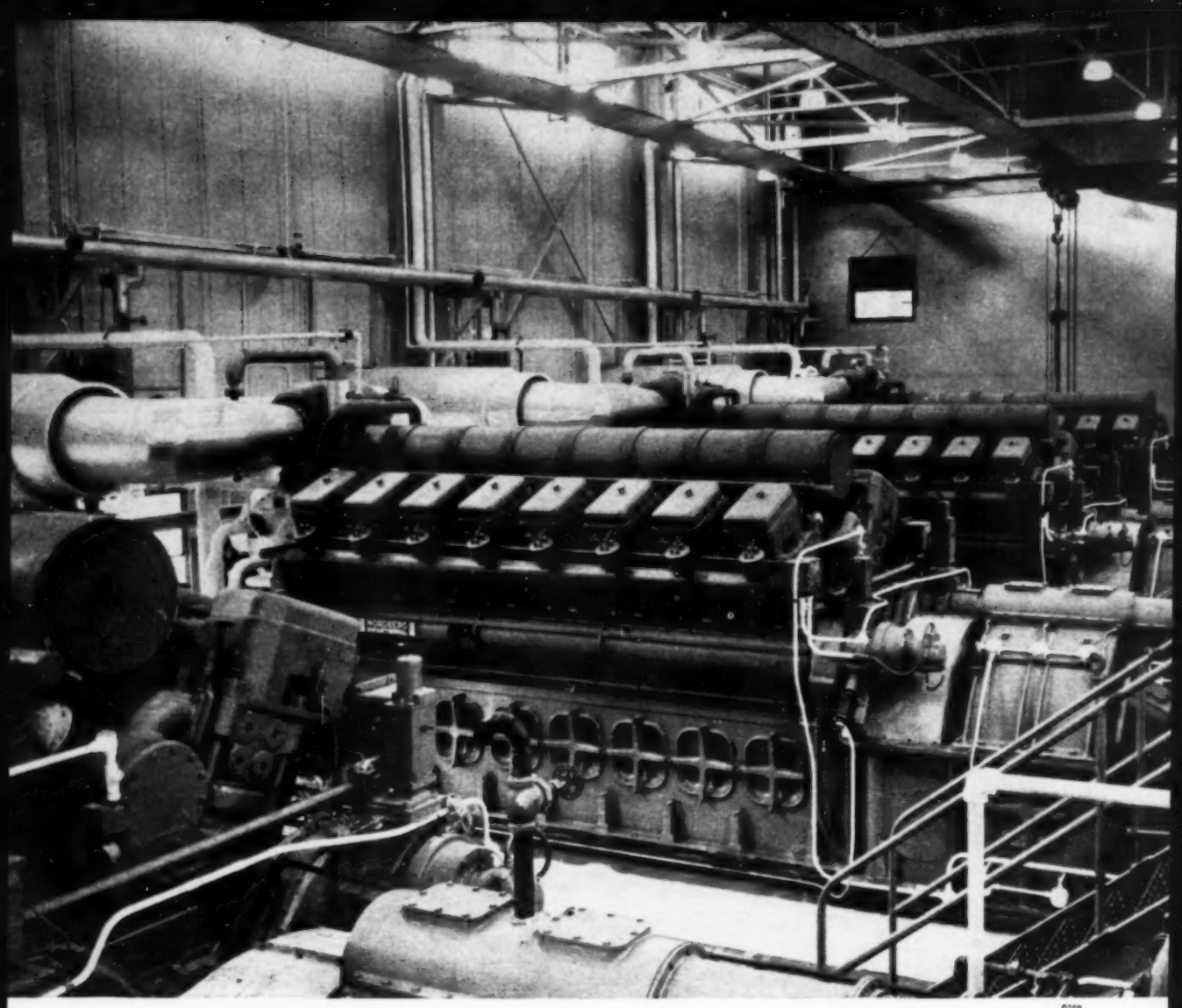
TELETYPE®
CORPORATION
SUBSIDIARY OF *Western Electric Company* INC.

FIELD STATION is equipped with Teletype Model 28 ASR—an automatic send-receive set with built-in tape punch and reader.



TELEMETERING. Sub-station operates on unattended basis. Equipment may be a Teletype Sequential Selector—or, if a printed record is required at the unattended station, a Model 28 Receiver-Only Page Printer may be used. A multi-wire input device in both units makes possible conversion of parallel digital information to sequential transmission.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



Pipe line engines by Nordberg

Eleven Nordberg *Supairthermal*® spark-ignition gas engines are presently in operation at the second, third and last station along the new Westcoast Transmission Company Ltd. 30″ gas pipe line in western Canada. Each of these units consists of a 16-cylinder Nordberg V-type engine, rated 3550 bhp at 500 rpm driving a 24″ x 24″ centrifugal gas compressor thru a built-in, 10:1 speed increasing gear.

NORDBERG MANUFACTURING COMPANY
MILWAUKEE 1, WISCONSIN

ATLANTA • CLEVELAND • DALLAS • DULUTH • HOUSTON • KANSAS CITY • MINNEAPOLIS
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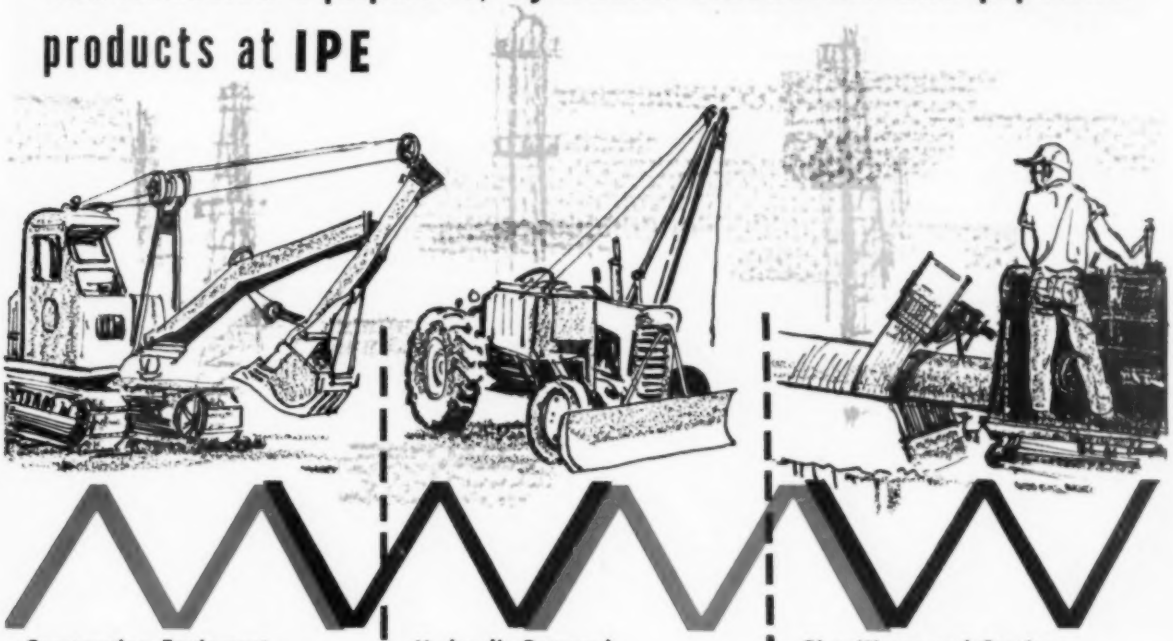
MIDWESTERN to show latest developments in construction equipment, hydraulic sidebooms and pipeline products at IPE



Construction Equipment . . .

. . . to be shown by Midwestern Engine & Equipment Company will include a new model of the Pitman Hydra-Lift and a Pitman Aerial Platform. The latest models of such well known equipment as a Unit Crane 1220 Backhoe . . . a Model 2460 Gradall . . . a Marion 43M Power Shovel . . . Barnes Self-Priming Centrifugal Pumps . . . Esco Trencher Points and Adapters and Ottawa Hydra-Hammers will also be on display.

Hydraulic Powered Sidebooms . . .

. . . to be shown by Midwestern Manufacturing Company will feature a new model boom designed for use on rubber tired tractors such as the Oliver 770 and the Ford 184. Midwestern Manufacturing will also show four models of crawler tractors equipped with Hydraulic sidebooms and angle backfill blades. These will include an Oliver OC9, an Oliver OC4, a Caterpillar D4 and a Case 600.

Pipe Wraps and Coatings . . .

. . . displayed by Midwestern Pipe Line Products Company will feature two new products . . . SPEEDKOTE, an asphalt base coating designed specifically for fast set-up, and SPEEDWRAP, a prefabricated joint cover designed for fast wrapping in the field. Other products to be shown include Keystone Asbestos Pipeline Felt, Kermac Outerwrap, Coromat Underground Pipe Wrap, Kapco Rock Shield, Permacel Tapes and Glasfab Pipe Wrap.

Visit the Midwestern display at Block 107 and examine the latest developments in Construction Equipment, Hydraulic Sidebooms and Pipeline Products. Our engineers will be on hand to answer your questions and demonstrate features of the equipment and products on display.

MIDWESTERN

EQUIPMENT • MANUFACTURING • PIPE LINE PRODUCTS

4645 Southwest Blvd. **Tulsa, Okla.**

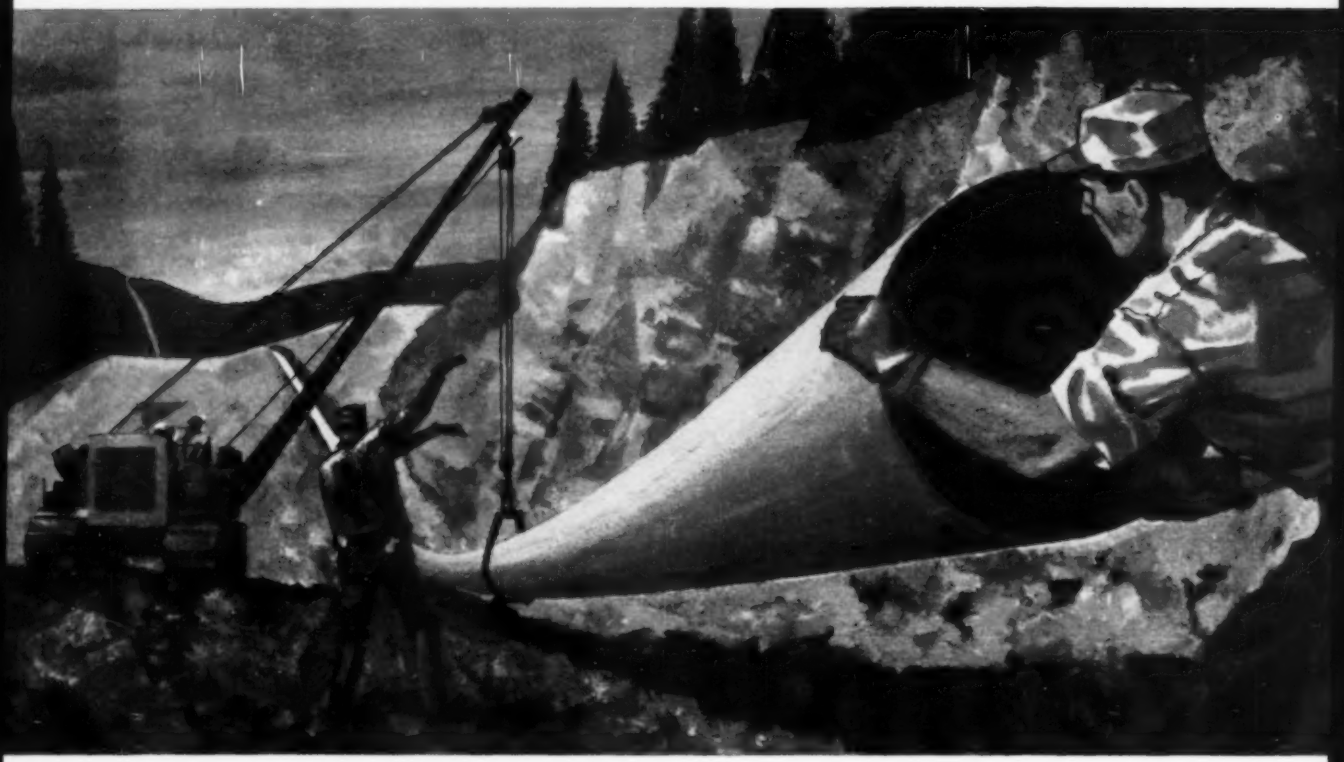
Cable Address: Mid Pipe **Phone HI 6-6144**

Putting the Laurel to bed

That's The Laurel Pipe Line! Recently completed, this 440-mile line is the first to use 24-inch-diameter pipe in a major cross-country refined products system.

Gasoline and other petroleum products will be transported through the line from Delaware River Valley refining centers to inland marketing areas such as Reading, Harrisburg, Pittsburgh and Cleveland.

National Tube supplied the pipe for the Laurel Line—approximately 66,000 tons of USS National Seamless and Electric Weld Line Pipe in sizes 24" O.D. to 14" O.D. for the main line and 9,000 tons for feeder lines, take-offs, and terminal facilities.



The eastern section of the main line, some 135 miles, is 24" diameter, API 5L X-52 pipe, ranging from .281 to .375-inch wall thickness. Initially, the line's throughput is expected to be about 100,000 barrels a day; however, this can be increased to 300,000 barrels with additional pumping stations. This line will make a greater variety of refined products available, in increased quantities, at a considerably lower transportation cost.

The Laurel Pipe Line represents another first for USS National Line Pipe. Why is USS National consistently chosen for rugged line pipe assignments? The answer in a word: *Performance*. You see, National Line Pipe combines the qualities of strength and dependability to give you a better product. Remember, too, that National Line Pipe is available in a complete range of wall thicknesses, steel analyses and in diameters up to 26 inches in Seamless and up to 36 inches in Electric Weld. For more information, write to National Tube Division, United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

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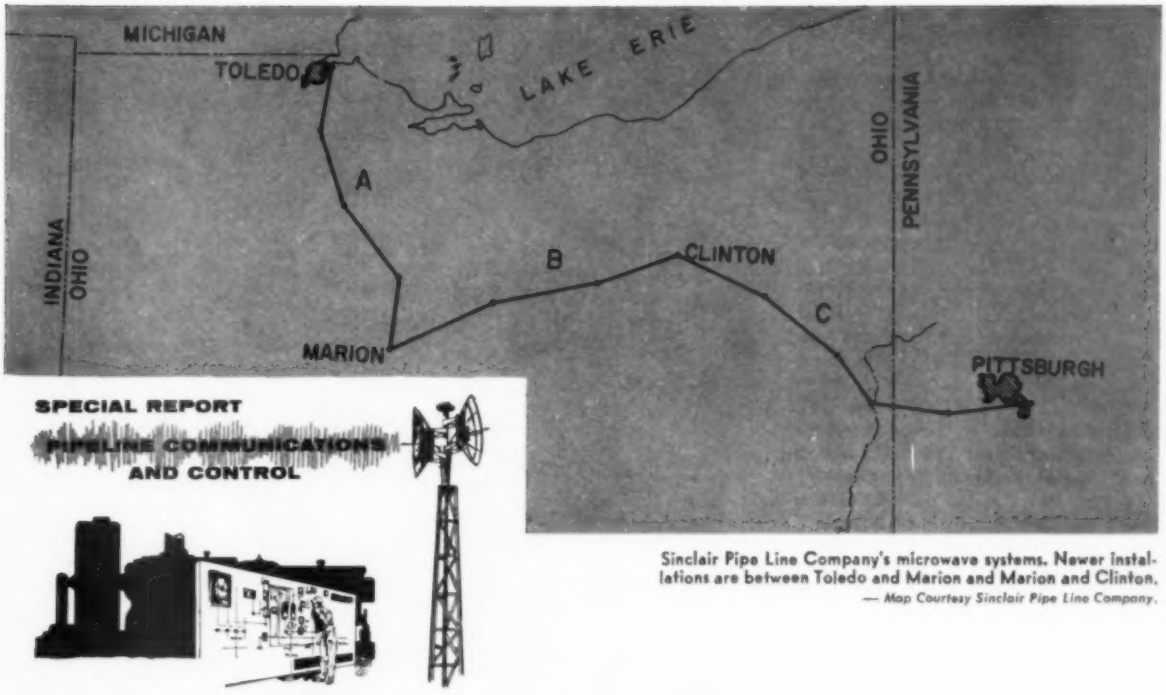
National Tube Division of USS **United States Steel**

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
United States Steel Export Company, New York



Sinclair Pipe Line Company's microwave systems. Newer installations are between Toledo and Marion and Marion and Clinton.
— *Map Courtesy Sinclair Pipe Line Company.*

MICROWAVE—99.9% CONTINUITY OF OPERATION IS NO LONGER UNUSUAL

L. E. Cook, *Superintendent, Communications Department, Sinclair Pipe Line Company*

A MICROWAVE SYSTEM capable of 99.9 percent continuity of operation, even over extended distances, is no longer an engineer's dream — it is a reality. Advances in technical know-how on the part of both the manufacturer and the user are reflected in improved systems installed during the last few years.

Experience is the best teacher in any endeavor, and in the microwave field this has certainly been true. Ten years ago neither the manufacturer nor the user was blessed with previous experience with operating systems over any appreciable distance. Therefore, microwave systems were purchased through loosely written specifications or in some cases by letter of intent.

The manufacturer encountered many problems during field installations of long systems that had not been apparent in testing systems in laboratories or over one hop paths. The user was not familiar with many characteristics of the equipment he was buying and so could not anticipate many of the problems he would inherit. Thus, many systems were manufactured and

Dispatcher at Marion communicates with other stations via microwave to coordinate pipeline movements. Display board in background contains up-to-minute report on pipeline operations.
— *Photos courtesy RCA Communications Products Department*

installed only to be re-engineered and modified in the field before satisfactory performance could be achieved. It is not surprising that many of the earlier systems fell far short of the desired 99.9 percent continuity.

Today, both the manufacturer and the user can draw upon a wealth of past experience. Most of the manufacturers have improved their systems to a degree that the desired performance is available. The user knows what the equipment will do and can write his specifications to obtain the degree of performance he desires consistent with the amount of money he desires to invest.

Sinclair Pipe Line Company had constructed three microwave systems of major size by the year 1955 and in each a major portion of the engineering was done by company engineers. Sites were selected, buildings designed, tower specifications written, paths between repair sites surveyed, and certain performance limits were specified for the microwave equipment. These systems all performed in the range of 95 to 99 percent continuity and their operation was generally satisfactory.

Performance Requirements

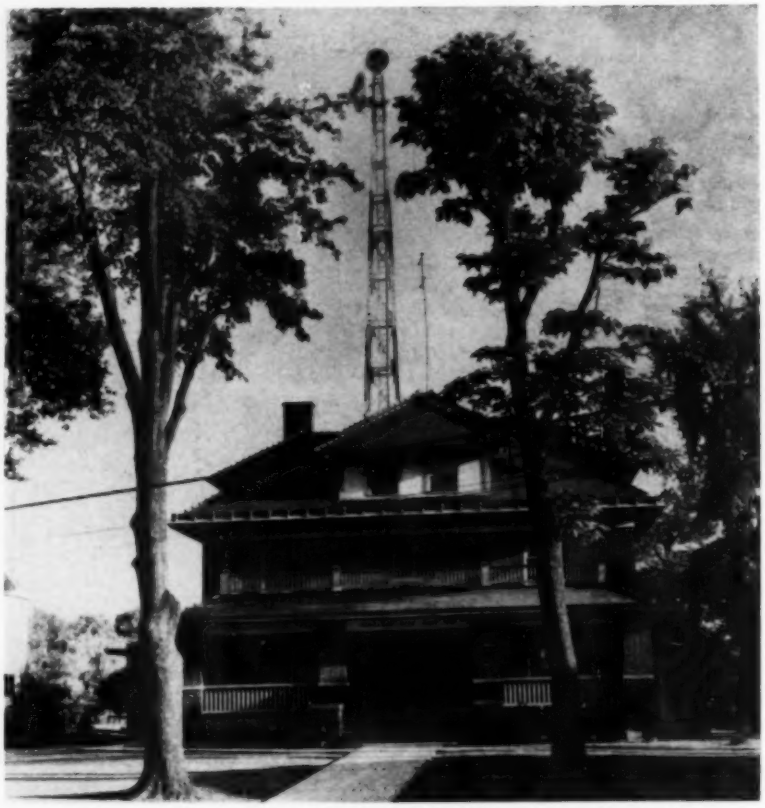
Experience gained by Sinclair's engineers in these first systems convinced them that gaining a portion, or all, of the last few percentage points of continuity was possible. They began to include in their specifications, beginning in 1955, certain performance specifications designed to gain this extra percentage. Some of these requirements are as follows:

1. **Continuous power.** The manufacturer or supplier is required to provide a power standby so that microwave system interruption will not exceed 25 milliseconds on each occasion of primary power supply failure. To meet this requirement the manufacturer or supplier must provide a continuous power supply, batteries, or an interim power supply to carry the microwave system while the engine cranks.

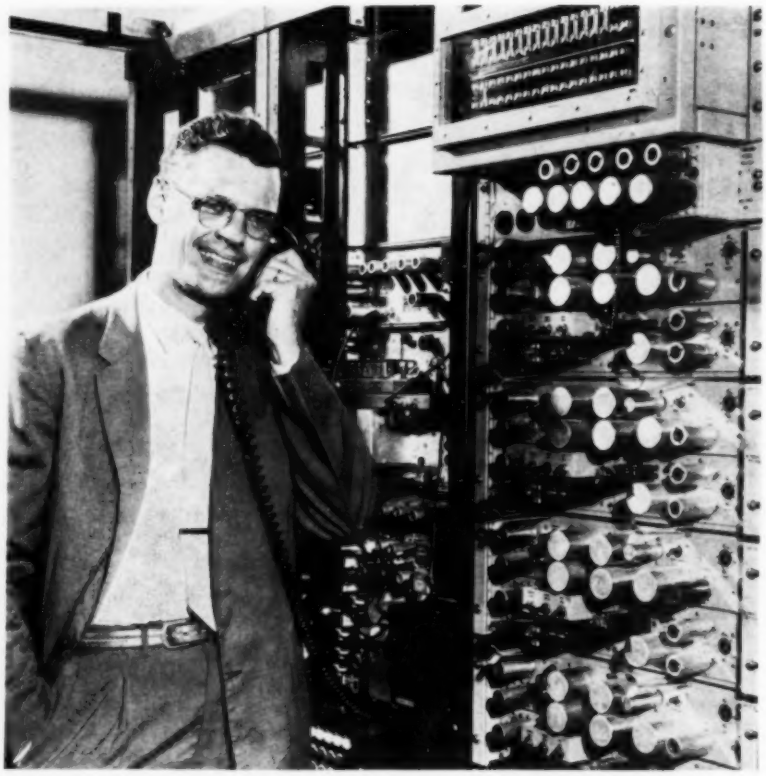
2. **RF continuity.** The manufacturer is required to provide standby RF equipment that will be placed in service automatically to replace any regular RF unit upon failure of the regular unit, and interruption to service due to switching from a regular to a standby unit or the reverse is not to exceed 25 milliseconds.

In order to meet this requirement the manufacturer has to provide hot standby with fast wave guide or co-ax switching, or a dual beam system that furnishes continuous standby for the RF equipment, antenna system, and over the path itself.

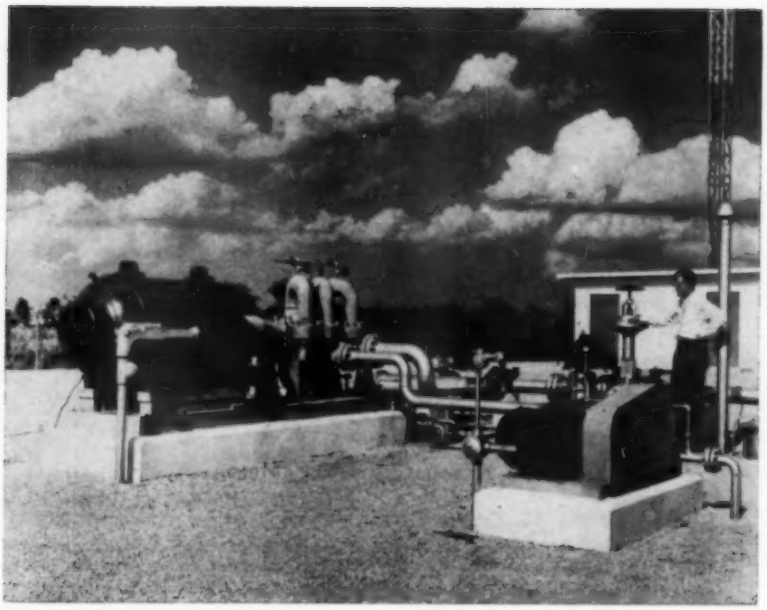
3. **Signal-to-noise and fade margin.** The signal-to-noise ratio for all voice



Self-supporting tower on top of Sinclair's Marion, Ohio, division office building.



Routine check is made on microwave relay equipment installed at Sinclair's Marion headquarters.



RCA microwave system provides communication facilities to remotely control pumping operations at Fostoria, Ohio, station.

channels is required to be not less than 50 db, F1A weighted. It is further specified that the signal-to-noise ratio on any channel shall not decrease below 35 db, F1A weighted, when a 30 db attenuator is inserted in the input to the RF receiver at any station in the system. The first system purchased after this requirement was put into effect exceeded this performance considerably so that subsequent specifications have read "shall not decrease below 40 db, F1A weighted." In some cases, this has caused manufacturers to use higher gain antenna systems on some of the longer hops.

In addition to these three major increased performance requirements, general specifications covering RF and multiplex have been revised in many cases to up-grade quality and provide operational advantages.

Sinclair's Newer Installations

Sinclair Pipe Line Company in recent years has completed additions to its system in Ohio that were constructed under this program for 99.9 percent continuity. One addition was an 82.5 mile, four-hop system from the division office at Marion to Toledo, shown as A on the map. Another was an 82.3 mile three-hop extension from the Clinton pump station to the Marion division office shown as B on the map. The section designated as C was completed in 1956.

The two sections were awarded to manufacturers under competitive bidding on specifications drawn up by Sinclair. Tower heights, station locations, and path profiles previously had been determined and incorporated in the specifications so that manufacturers were bidding to furnish and install microwave equipment and guarantee its performance as required by the specifications. Towers, buildings, power, and other non-electronic portions were provided by Sinclair and made ready before the microwave equipment was installed.

The section from Marion to Toledo was awarded to Radio Corporation of America. The equipment supplied by RCA for this system is their type CW-20A-AW operating in the 1850-1990 mc band. The multiplex equipment is single sideband suppressed carrier type with a maximum capacity of 30 voice channels as installed. In addition, a quantity of telemetering channels can be operated on the baseband below the regular voice channels. The system was initially equipped with five voice channels, and telemetering and control channels were placed on the baseband as well as two wireline carriers.

The section from Clinton to Marion was awarded to Kellogg Switchboard and Supply Company. Equipment supplied by Kellogg was Type 10-C dual beam system operating in the 1850-1990 mc band. Multiplex equipment is pulse position modulation with a capacity as installed of 23 voice channels.

Both of these sections were placed in operation during 1958.

Towers, buildings, fences, gasoline tanks, and other non-electronic installations were supplied and installed by Andrews Tower Company of Ft. Worth, Texas. Buildings were two-room poured concrete type with foundation, floor, walls, and roof of steel reinforced concrete. One room houses the electronic equipment and one room the emergency power. Towers are square, guyed towers (with heights from 160 to 320 ft) at all locations except Marion and Toledo. At the Marion division office an 80 ft square self-supporting tower was erected on top of an office building wing. At Toledo a triangular tower was especially designed because of special guying considerations.

Operating Results

These two sections of microwave have replaced portions of company owned wire lines to provide additional channel capacity and greater reliability. In this area ice storms have disabled the company wire lines several times during the last few years and future protection of communications from outage due to storms will be welcomed. Also, extra circuits can be added easily at low cost to take care of expansion of pipeline communications.

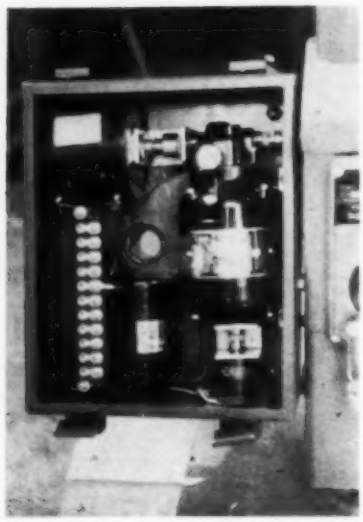
The first months of operation for these two systems indicate that the 99.9 percent reliability will be achieved as several 100 percent months already have been logged. The Pittsburgh-Clinton system marked C on the map logged 100 percent operation in 17 of the first 22 months it was in service.

Planned programs are underway to upgrade some of the company's older systems to approach 99.9 percent continuity. These older systems have a loading density up to 30 voice channels with many control and telemetering sub-channels, which makes even a small gain in continuity extremely important to the company's operations. ★ ★ ★

L. E. Cook *is superintendent of Sinclair Pipe Line Company's communications department, with headquarters in Independence, Kansas. Cook joined Sinclair Pipe Line in 1948. A veteran of almost 20 years' communications experience, he is vice chairman of American Petroleum Institute Radio Committee, vice chairman of National Petroleum Radio Frequency Coordinating Association, petroleum industry representative on the Operational Fixed Microwave Council, and member of the API Automation Committee.*

SPECIAL REPORT
PIPELINE COMMUNICATIONS AND CONTROL

DIESEL-POWERED BOOSTER STATIONS CAN NOW BE COMPLETELY UNATTENDED



Electric governor speed-setter mounted on PG governor before installation on engine.

New all-electronic control equipment solves problem of remote operation for this type of pumping installation

F. G. Hausmann
Senior Engineer
Sohio Pipe Line Company

SUCCESSFUL OPERATION of diesel-powered pipeline booster stations by remote control has become an accomplished fact on the Inland Corporation's Fostoria-Mogadore products line in Ohio. From experience it can be said that there is now no more concern about starting a diesel-drive pump station from miles away without anyone in attendance than there is in starting an electric station.

Two 1250-hp diesel pump stations, at Burbank and East Liberty, were constructed in the fall of 1956 by the Inland Corporation. The stations were put into operation early in 1957. Some difficulties were encountered with the reliability of the all-electronic control equipment, due to the fact that some of the equipment, such as the proportional-reset action electric positioned engine governor, had not existed before this application. The problems have been solved and the stations have been operating with a reliability factor of 90 to 95 percent.

Sequence of Operations

Operation of the stations is very similar to those of electric motor type except for engine controls. To illustrate the operation the general sequence of events are as follows:

When notified that additional throughput is required on the Fostoria-Mogadore section, the operator at Fostoria terminal checks line pressure and indicator lights on the remote control and indicator panels for the Burbank and East Liberty stations. After determining that line conditions are satisfactory, and the station cleared to start, he pushes the start button. The Fostoria-Mogadore line being reversible, pumping both east and west, the station that is started first depends on the direction in which the line is operating.

The start signal is coded out on its assigned frequency over a single voice grade telephone circuit, which is also transmitting the station suction pressure, discharge pressure, and station function indications for both stations at their respective assigned frequencies.

The start signal is received at the selected booster station, and, after acknowledgment to Fostoria is made, a relay closes initiating the station "start" sequence. Start-up takes approximately two minutes, during which time the station isolating valves open, the engine jacket water heater is de-energized, circulating pump stopped, station suction pressure scanned, the fuel line to the engine opens, the electric starting motor is energized, and the engine started. At the end of this two-minute period the engine is running and the operating conditions of the engine are monitored. If the operating conditions are satisfactory the engine enters the idling period, which lasts for five minutes.

When the idling period is completed, the engine speeds up until one of the preset pressure controllers, either minimum suction pressure or maximum discharge pressure, takes over control and the station is on stream.

During the start-up and idling periods, and while the station is on stream, the engine and station protective devices are in continuous operation. If any protective device is activated it shuts down the station and indicates to the Fostoria control panel the fault that occurs. If the shut-down was caused by transient line conditions, e.g., low suction or high discharge, the operator at Fostoria can reset the controls at the station and start the station again. If the control panel indicates a station lock-out fault, he cannot start the station and a maintenance man must be dispatched to correct the difficulty and reset the station controls.

The present maintenance program provides for a maintenance man to visit the stations once a week to check oil and water levels, change charts, empty the sump, inspect filters and generally observe operation of the unit.

Station Housing

Station equipment is housed in three

East Liberty, Ohio, pump station during construction.

prefabricated steel buildings, one housing the diesel engine and speed increaser, another the pump, and the third containing the local and remote control equipment. A fourth small building is used for storage of supplies.

Engine and pump buildings have a 6-in. air gap between them to prevent hydrocarbon vapors from entering the engine building and to isolate any possible fires. The control building has a year-'round air conditioning unit to provide optimum atmospheric operating conditions for the all-electronic control system.

A 1500-bbl fuel oil tank is located at the station to take fuel oil for the engine from the pipeline.

Engine and Pump Types

The engine selected for this installation was a skid-mounted 1250-hp, 2-cycle, V-12 water-cooled standard railroad locomotive engine with a speed range of 300 to 815 rpm. It drives a 6-in., 6-stage centrifugal pump through a speed increaser with a 5:1 gear ratio. A shell-tube type heat exchanger placed on the discharge side of the pump serves to cool the jacket water and lube oil for the engine and the lube oil for the speed increaser.

Auxiliary equipment for the diesel engine consists of a d-c starting motor driving a bull gear on the engine flywheel. The starting motor receives its energy from a 125-v d-c battery bank, which is kept on a trickle charge, the power being provided by the local power company. An electric heat exchanger and small circulating pump keep the engine jacket water near the operating temperature when the station is shut-down.

Protective Devices

Engine protective devices detect high jacket water temperature, low lube pressure, high lube vacuum, and engine over-speed.

Speed increaser protective devices consist of low lube pressure detection and high bearing temperature on both the bull gear and pinion gear.

The pump is protected for high bearing and case temperature, excessive seal leakage, and excessive vibration.

The station itself is equipped with fire detection and extinguishing equipment, so designed as to operate only in that building in which fire is detected.

Engine Starting Unique

It was mentioned before that an electric motor was used to start the diesel engine instead of a pneumatic starter. This type of operation and elimination of an air compressor and drier was made possible by the use of an electric positioned governor that has not been available previously. For this application a standard PG governor was used and adapted so that the speeder rod could be positioned by a small 1/70-hp induction motor.

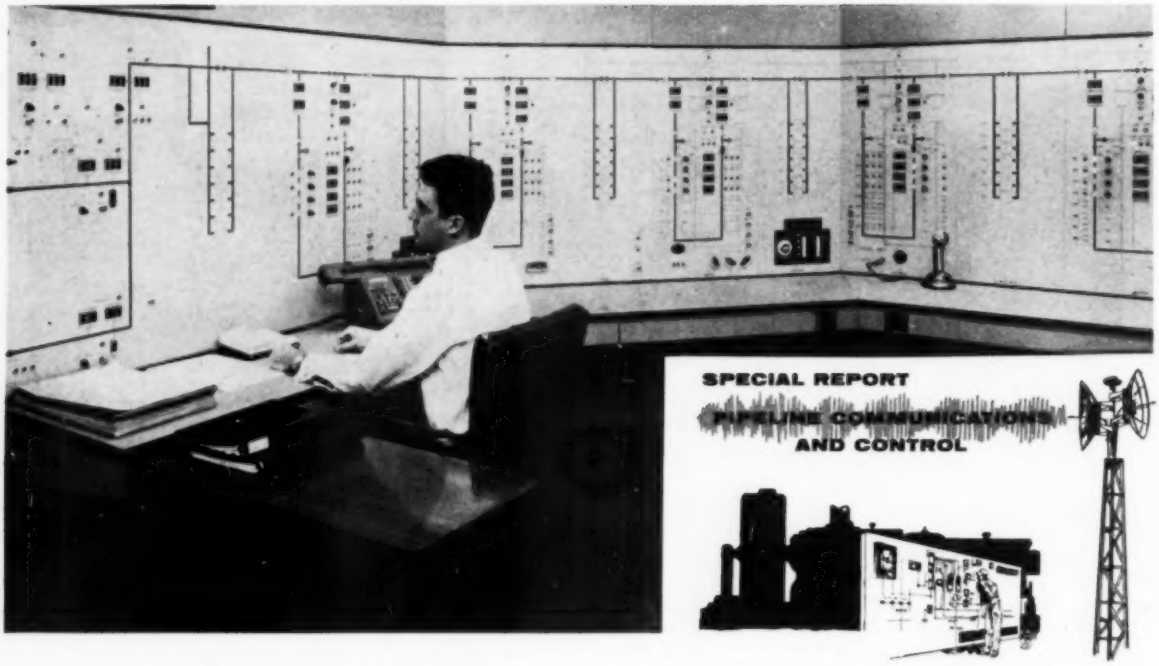
This small motor not only drives the speeder rod of the governor but also a small d-c generator and a precision potentiometer. This complete unit as described here is referred to as a governor speed-setter.

To better understand the operation of the governor speed-setter, its operation should be observed from the time the engine enters its idling period. At this time the engine speed is under the control of a programmer, which is feeding a milliampere signal to a three-way over-ride switch along with the signals from the suction and discharge pressure controllers, which have proportional and reset action. Purpose of the over-ride switch is to select the most dominant signal of the three and control the speed of the engine in a linearly proportional manner over the speed range of 300 to 815 rpm.

During the idling period the programmer signal is the dominate one, but after the period is timed out, the engine begins to speed up under control of the programmer at an acceleration rate of 500 rpm, up to the point where the "crossover" occurs between the programmer signal and the dominant controller output signal. That is, the programmer signal decreases, causing a proportionately increasing engine speed; suction pressure decreases and discharge pressure increases, each approaching its controller set-point, until it builds up a resulting controller output signal sufficient to over-ride the decreasing programmer signal and therefore "take over" control of engine speed from the programmer whose signal reduces linearly to zero. Engine speed is then controlled by the more dominant of the two controller outputs.

Most critical part of the circuitry is the feed-back and zero-plugging brake action on the governor speed-setter motor. The dominant control signal is compared with a signal from the diesel engine governor speed-setter proportional to the speed-setter position, and any "error" or difference between the two signals actuates a reversing starter, causing the speed-setter motor to be driven in the proper direction so as to "null" or reduce the error to zero. By this method the position of the governor speed-setter, and therefore the engine speed, continues to correspond with the dominant control signal. To prevent "hunting", a zero-plugging braking action is provided on the speed-setter motor as the "null" or zero error condition is approached.

The development of this all-electric positioner, which has been adapted to control valves as well as to engine governors, has completed the electronic control loop. It is undoubtedly going to find greater application in remote control station design where maintaining a good dry air supply for the control system has been a problem. ★ ★ ★



The control console at Nashville is the focal point of the Columbia Gulf Transmission Company's automatic pipeline system. It is divided into three sections, each of which is 6 ft wide, 2 ft 4 in. deep, and 7 ft 6 in. high. The light-green front panel forms a contrasting background for the dark-blue and yellow lines representing the pipeline and compressor station piping.

HOW WORLD'S FIRST PUSHBUTTON GAS PIPELINE SYSTEM WORKS

From console in Nashville, Tennessee, one man controls and monitors five stations over 841 miles of pipeline

David G. Emmel, *Project Engineer*
Union Switch & Signal
Division of Westinghouse Air Brake Company

A DISPATCHER in the Nashville transmission headquarters of Columbia Gulf Transmission Company walked over to a gigantic control panel occupying an entire wall of the room. He glanced momentarily at the varicolored panel with its multiple controls and depressed the first of several small switches. In itself, the initial movement was slight, but in significance the motion was an historical milestone in the annals of the pipeline industry.

For, when the switches were depressed and turned, the first of five 14,000-hp automatic stations . . . each spaced some 180 miles apart along an 841-mile main line . . . was placed on completely unattended remote operation from a central location. This first automatic station is at Hartsville, Tennessee. Within a matter of days, three additional stations, at Stanton, Kentucky, Corinth, Mississippi, and Alexandria, Louisiana, also became unattended remote stations.

Thus, for the first time in the history of natural gas transmission, it became possible for *one* man to monitor and control the flow of gas through an entire pipeline system. In effect, the Columbia Gulf Transmission Company began operating the first pushbutton gas pipeline system in the world.

The ultra-modern control console and its related equipment comprise the world's largest completely integrated centralized transport control system. The system was designed and manufactured by Union Switch & Signal — Division of Westinghouse Air Brake Company and delivered to the Columbia Gulf Transmission Company after more than five years' planning and development. Actually, the pushbutton pipeline evolved from theory to design to the practical operation of an experimental satellite station at Stanton, Kentucky, in less than two years. The Stanton station was the prototype for the five fully automatic centrifugal-compressor stations spaced along the main pipeline and alternated with five semi-automatic stations.

Center of operations for this inte-

grated system is Nashville, Tennessee, where the remote control console has been placed in a specially designed dispatcher's room on the 22nd floor of the Life and Casualty Tower.

Designed to permit maximum operating efficiency at a minimum operational cost, the console monitors and remotely controls four 3500-hp supercharged internal-combustion engines situated at each of five locations on a 30-in. diam main line 841 miles long between Rayne, Louisiana, and the Kentucky-West Virginia border. A total of 70,000-hp is being operated directly and entirely from the Nashville office. As stated, this is the longest stretch of gas pipeline ever to be controlled and monitored from a single, integrated location.

Reliability of the system is augmented by built-in levels of security to insure integrity of operation.

From his position in front of the console in Nashville, a dispatcher is able to:

1. Monitor operating conditions including rate of flow and pressures at four major points, and water content at four locations along the gathering system in southern Louisiana.

2. Operate the five automatic centrifugal compressor stations, start or stop any or all of the four engines at each station, shut down any station when necessary, control discharge pressures, and monitor operating conditions of all 20 engines and all five stations.

3. Control the flow of gas leaving the line at the delivery points at Leach and Means, Kentucky, and monitor flow and pressure conditions.

The office panel of the dispatcher's console contains digital indicators for the display of data transmitted from the stations along the pipeline. These indicators provide an instantaneous display of important operating variable as they exist at the several stations. These variables include suction pressure, discharge pressure, engine speeds, and discharge pressure controller set point. The system provides for the automatic control of station discharge pressure, which can be digitally set either from the dispatcher's console or the remote station.

In addition to the dispatcher's control console, equipment is included to control the four engines at each of the five locations. The control console contains all necessary control levers, indication lights, digital indicators, and required code transmission equipment.

Provided at each of the five stations are identical cabinets to house equipment for those functions common to station operation, and one cabinet each for the control of each individual engine.

Station equipment also includes instrumentation to receive and transmit information to the distant dispatcher's office and all sequence, protective, and alarm equipment.

Engine cabinet equipment consists of materials necessary to sequence each engine to operation on and off the pipeline. The face plate of the engine cabinet has a 40-drop annunciator at eye level, a three-position selector lever designated stop and start, and six lights designated alarm, shut-down lockout, shut-down restart, run, local and remote located just under the annunciator. A speed recorder and pneumatic controller is situated below the lights and levers.

The front panel of the console is light green in color to form a contrasting background for the dark blue and yellow lines representing the pipeline and compressor station piping. The entire control console is divided into 12 equal-size panels. Ten intermediate panels are numbered 1 to 10 and represent as many pumping stations on the line. The two end panels contain monitoring and control equipment for six metering stations.

The console provides for the control of four existing engines and four future engines represented as five stations along the dark blue line running the length of the front panel; however, no equipment or indications are provided for these future engines at this particular time.

In addition, the upper yellow line representing a future second main line is engraved but presently contains no indications to show the operation of equipment. Accommodations are included for such indications when operational equipment is added at a future date. The face of the console is engraved in its entirety so that these future additions can be made without replacing any of the panels.

Planning of the Columbia Gulf Transmission Company is such that in the immediate future there will be two parallel pipelines. Therefore, arrangements have been included in this console to permit engines at any station to be sequenced to either line (blue or yellow) depending on the proper positioning of a turn-push start button. The engine loading valves selected by this operation eventually determine onto which line the engine is put in operation.

Dispatcher Operation

From left to right, in their proper sequence on the pipeline, there is one panel for the gathering system, one for each semi-automatic station, one for each automatic station, and one for the delivery points at Leach and Means. For example, the first panel will show the dispatcher the flow, static pressure, and number of metering tubes in operation at two major gas supply points—Paradis and Erath, Louisiana. Flow and static pressure at Duson and Crowley, Louisiana, which are check measuring locations on the east and west laterals, are also indicated on this panel. There are lights to indicate the range of the water content of the gas passing through four main junctions of the gathering system.

At the opposite end of the board, the dispatcher is able to control the flow of gas out of the system at Leach and Means. There is a set point selector that enables the dispatcher to set the desired gas delivery rates. When he pushes the send button, the equipment at the transport measuring station will automatically adjust the number of metering tubes in service and re-position the flow controllers to meet that delivery. Flow rates, static pressures, differential pressures, and the number of metering tubes in operation at both Leach and Means are shown on digital indicators. The same set point selector is used to set the discharge pressure at each of the compressor stations. When a set point is sent to a station, a discharge pressure controller automatically regulates the rpm of the engines in service to meet and maintain that pressure.

Plans are now in progress to automate the five 14,000-hp reciprocating stations, which will be controlled in a manner similar to that of the five centrifugal stations. Panels for the automatic centrifugal stations tell the operator the suction and discharge pressures, rate of flow, and rpm of each of the four engines at each station.

Arrow-shaped blue lights in appropriate locations are illuminated when important gas control valves in the station yard are open. These are the side gates, fire gates, loading gates, and block valve. Lights are off when these valves are closed.

Vertical blue lights illuminate to show which engines are running. Orange lights beside the engine lights are lit when engines at any of the stations are being operated on local sequence. When the orange lights are out, the dispatcher knows he has remote sequence control of the engines.

Starting an Engine

To place an engine on the line the dispatcher actuates the starting sequence by depressing the engine start switch. He knows the signal has gone out by the appearance of a flashing white light. A steady white light shows when a code is sent from the station and is being received at the board.

At the station the received signal energizes a bank of relays, which sets

in motion the process of starting the engine. As soon as that is done a feedback signal initiated at the station returns to the board and is displayed as a flashing blue-bar light. This light is the engine running-condition indicator. The feedback signal tells the dispatcher the code has been received correctly and the starting sequence is being activated.

At the station, meanwhile, the process started by the coded signal is still going on. Intelligence is passed on automatically from relays to switches, to energizers, and other devices. Compressed starting air rolls the engine to cranking speed, the ignition comes on, and the fuel gas is turned on. When the engine begins to run, the starting air goes off, and the engine comes up to starting speed. Then the discharge valve opens, the centrifugal compressor goes into action, and finally, the suction valve opens and the compressor goes on stream under the direction of the discharge-pressure controller. A similar process is followed when the engine is shut down.

An engine will not obey a start or stop order until all conditions for the action are correct. The dispatcher observes the results of the starting or stopping sequence by viewing the board. Automatic control of a station is not dependent on the telemetering circuit. When a telemetering circuit failure occurs, the station will continue to run fully protected and in complete control. It will operate following the last orders it received until the circuit is restored or the station is taken over locally.

For present operation, there is an individual communication line provided to each station with the ultimate arrangement of one line serving each pair of stations. Leased from the telephone company, the lines operate on a half duplex principle to minimize operational costs.

Safety and Warning Functions

There are also shut-down lockout, shut-down restart, and alarm lights for each engine. When the SDLO light is lit, the dispatcher knows instantly that a serious mechanical failure has shut down the engine and that the engine must be checked and the trouble corrected before it is restarted. The SDRS light indicates that a minor complication has shut down an engine. The engine can be restarted and operated if the difficulty has cleared itself. When the alarm light for an engine comes on, the dispatcher knows there is a faulty condition to be checked, but that it is not serious enough to shut down the engine.

Another set of lights on each panel shows the pressure ranges for station engine starting air. A warning light and bell alert the dispatcher that a station alarm has been actuated. The AC off light comes on when a power failure occurs at a station. The Nashville AC off light comes on if there is an electrical power failure in the Nashville office. In event of AC failures, however, the board and stations will continue to function from storage batteries, which automatically take over the electrical load of the controls. A surge light indicates when compressor surge or no flow conditions are encountered at the station.

The station test-light comes on to inform the dispatcher that plant personnel are doing work that requires the by-passing of certain electrical engine safety devices. During such occasions, the engines are on local control and protected with basic pneumatic safety devices. A circuit fault light on each panel tells the dispatcher when there is a malfunction in the telemetering circuit between Nashville and a station. There is a station shut-down button for the dispatcher to actuate for purposes of taking an entire station off the line in an emergency.

The data recall button, when pushed, roll-calls and scans all digital indicators on the panel to recheck information displayed there. The indication recall does the same with the light indicators representing the alarms, valves, and engines. The lamp test is pushed to verify whether all lights on the panel are working. A set point deviation light informs the dispatcher when the discharge pressure at a compressor station varies from the requested order. The code cancel button permits the dispatcher to stop a signal in progress.

Digital Telemetering

Each of the panels is linked to its station by a minimum-cost leased communication circuit. Coded signals — a different one for each control function —are initiated on the board and travel over the circuit to the station. There, the coded signals actuate relays and switches, which in turn carry out orders received from the board. When a button is pushed, every part of the sequence of carrying out the order begins automatically. Similarly, telemetering data from the station to the board is automatically activated by change or call. There are also automatic safeguards that warn the dispatcher if his orders are not carried out properly.

Digital Computer

Intelligence is built into the equipment to determine when data should be sent to the office and brought to the dispatcher's attention. This system eliminates the necessity of demand-type telemetering. Data displayed in the dispatcher's office is continually maintained as current and accurate as the measurements at the compressor stations. All data between the control station and field stations are handled digitally without error in transmission. Receiving equipment will not accept any coded binary decimal that is not correct.

A main feature of the Columbia Gulf control console is the all-relay digital computer of novel design, which operates on telemetered data received from each of the pumping stations to compute gas flow to an accuracy better than one-quarter of one percent. This flow information is also displayed on digital indicators located on the console panel.

Differential pressure is received from the field and displayed in three indicators located in the control equipment. With the use of suction pressure and differential pressure, the computer is brought into operation and within one-half second computes the gas flow utilizing the formula that flow equals a constant times the square root of the absolute suction pressure times differential pressure. The constant is provided in the form of tap switches set at the proper digital value within the control equipment, out of sight of the dispatcher.

Logging Information

A data logging typewriter with a 30-in. carriage is placed upon a table at the right side of the control console. Data from various stations can be logged once every 15 minutes, half-hour, hourly, or on demand depending on the position of a selector lever. At any one time the log will show all information in a single typewritten line and will have the following format: Time, static pressure, flow, discharge pressure, and number of engines running at each of the five pumping stations. The present system does not include logging data from the five reciprocating stations.

The data logger thus frees the dispatcher from tedious logger chores and permits him to devote more time to the job of operating the pipeline. In previous operations, this information was taken by telephone at two-hour intervals.

Thus it can be seen that the dispatcher has a complete record of the operation of the pipeline at all times. Telemetered quantities are transmitted on a digitalized basis and displayed on digital indicators. Alarm and valve positions are indicated in the form of lights and controls are operated by the proper positioning of turn-push levers. Also, the logger will always provide a permanent record of the operation of the Columbia Gulf Transmission Company's line system. ★ ★ ★

MICROWAVE SYSTEM BROADENS SCOPE

Provision made to accommodate either frequency division or time division multiplexing, or a combination of the two

Kenneth P. Ray
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Communication Products Department
General Electric Company

DURING the last 10 years numerous technical papers[1-3] have discussed the advantages and disadvantages of frequency division and time division multiplexing equipment, and of 2000-megacycle (mc) and 6700-mc radio frequency (RF) equipment. Many conflicting views have been presented, even though based upon sound technical reasoning.

Time division equipment often is best for long-distance low-channel systems, whereas frequency division often is best for short-distance high-channel systems. Disadvantage of a smaller number of voice channels available with time division multiplex often is offset by its immunity from the ill effects of crosstalk caused by heavy channel loading in systems transmitting a great many tones.

With a view to providing maximum flexibility, General Electric has supplemented its 2000-mc Quadriphase line with a 6700-mc type UA-6 design to accommodate either frequency division or time division multiplexing, or a combination of the two.

The equipment basically is a vacuum tube design. Transistors have been used in proved circuits of optional accessories where their use offered definite advantages.

Electrolytic capacitors are not used in the basic equipment, but only in low voltage circuits in optional accessories. Power supply transformers and chokes are hermetically sealed to reduce the possibility of failure caused by moisture absorption. Relays in the basic equipment are hermetically sealed to prevent failure caused by dust accumulation or contacts.

Microwave circuits employ low power, conservatively rated reflex klystrons, which have a life expectancy in the order of 20,000 hr. A ferrite isolator minimizes the effort of any load

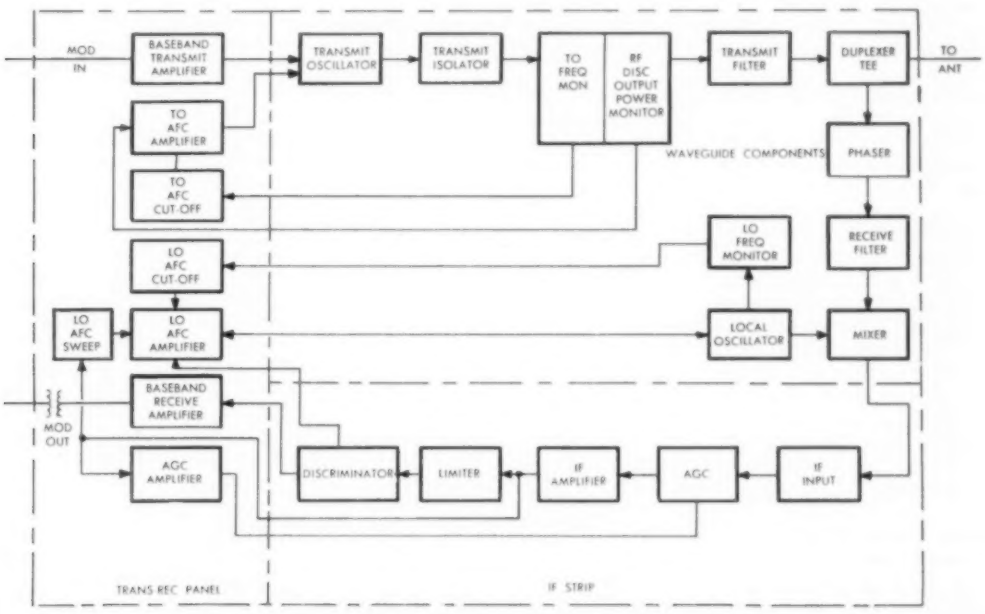

FIG. 1. Microwave terminal equipment.

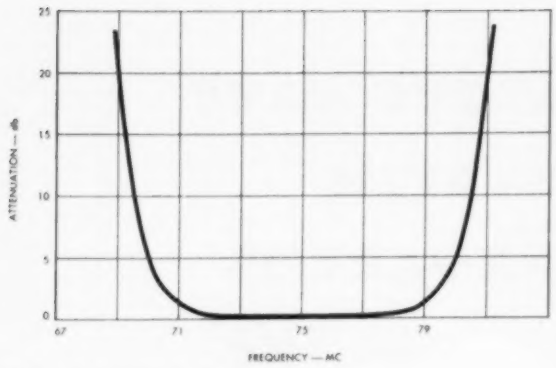

FIG. 2. IF response characteristics.

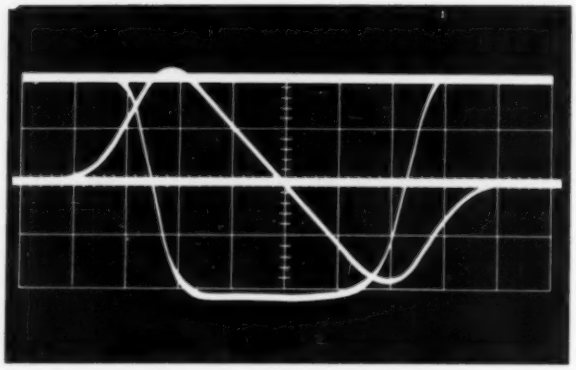

FIG. 3. Composite IF and discriminator response.

mismatch on the klystron. Use of the isolator permits the use of waveguide runs when the equipment must be separated from the antenna.[5]

Reliability of the system is further improved by use of the standby option, which automatically replaces faulty equipment with standby units. When it is necessary to drop or add channels at a repeater, a completely passive unit is used as a combiner between two basic terminals.

Careful circuit design is required to achieve good reliability even when long-life components are used. Feedback techniques are applied liberally to improve useful tube life, as well as stability of the system. Wherever transistors are used special compensating circuits are employed to minimize the ill effects of wide temperature variations. Automatic frequency control (AFC) is used on both the receiver and transmitter to provide maximum continuity of service. The receiver is also equipped with automatic gain control (AGC) to provide high quality service when the received signal varies widely.

To protect against propagation, as well as equipment failures, space and frequency diversity are both available. The diversity combiner provides a constant output without switching from one receiver to the other.

To determine field operation under the most severe ambient conditions, the entire system was tested in large environmental chambers. Complete performance tests were made over temperature ranges from minus 30 C to plus 65 C; over elevation ranges from sea level to 14,000 ft, and over humidity ranges approaching 100 percent. These tests were made for prolonged periods at each of these extreme ranges of conditions.

Maintenance Considerations

Despite careful selection of components and sound design, reliability of microwave equipment is a direct function of the maintenance quality. In turn, the quality of maintenance is a direct function of the provisions designed into the equipment to simplify maintenance.

In UA-6 equipment, metering jacks are provided for each tube. Built-in metering and switches are provided for routine maintenance. The equipment is modular in design with plug-in connections. All controls are conveniently situated on the front panels of the equipment. Those controls and switches used in routine maintenance are grouped at a convenient height for the technician. In order to easily and accurately check tubes while the system is operating, a switch is provided to decrease filament voltages by 10 percent.

Microwave "plumbing" circuits are made up of 11 individual components. Each component is independently adjusted, which provides flexibility in replacing or making adjustments. Each transmitter and receiver is equipped with a manually operated disconnect switch that removes these units from the antenna for maintenance checks.

Application Flexibility

As mentioned, the system makes it possible to operate with either time-division or frequency-division multiplex, or a combination of the two. Power sources are either a-c or d-c, using a static inverter.

Maximum utilization of the frequency spectrum is achieved by not fixing the separation between transmitters and receivers — any spacing from 60 mc up is satisfactory. The FM modulation swing is only $\pm$ 1.5 mc, permitting the use of a narrow band receiver.

System Description

A block diagram of the UA-6 system is shown in Fig. 1. Input signals are applied directly to the modulation amplifier, which performs the function of combining and amplifying the service and carrier circuits. Output of this unit directly modulates the transmitter klystron. The frequency modulated (FM) radio frequency (RF) output from the klystron is passed through a ferrite isolator, directional coupler (used for AFC), RF filter, and duplexer tee. Output of the duplexer tee may be connected directly to the antenna transmission line or to a phaser unit if it is desired to combine this system with another on the same antenna.

Received RF signals pass through a preselection filter and a directional coupler into the RF mixer. At this point the received signals are heterodyned (mixed) with the local oscillator klystron and the difference in frequency of 75 mc is applied to the intermediate frequency (IF) amplifier.

The local oscillator klystron is the same type as the transmitter klystron and is mounted in a section of waveguide adjacent to the main receiver waveguide. Output frequency of the local oscillator, which is 75 mc below the frequency of the received carrier, is coupled into the receiver waveguide assembly through a cross-coupled directional coupler. A variable attenuator in the local oscillator waveguide section controls the amount of local oscillator signal impressed on the mixer crystal and this is adjusted for optimum crystal current.

Beyond this attenuator there is an additional attenuator that can be used to adjust the signal entering the local oscillator frequency monitoring cavity. This monitor, which is factory tuned and sealed to a frequency exactly 75 mc below that of the received carrier frequency, is used to adjust the local oscillator klystron approximately on frequency.

Automatic frequency control (AFC) voltage, which is derived from the discriminator (IF), is applied to the repeller of the local oscillator klystron to maintain the exact 75 mc difference in frequency between the incoming carrier and local oscillator.

Output of the IF amplifier is amplified in the baseband receiver unit,

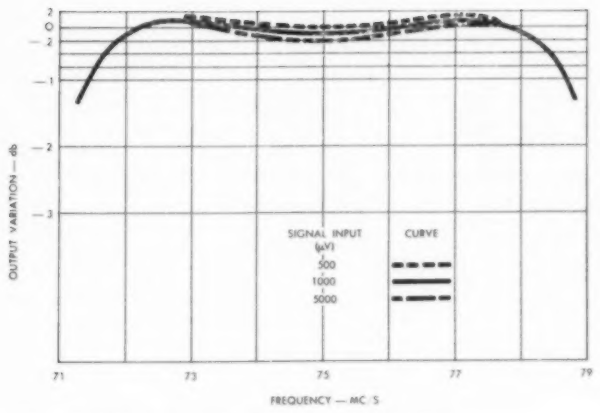

FIG. 4. Receiver baseband output vs. signal frequency.

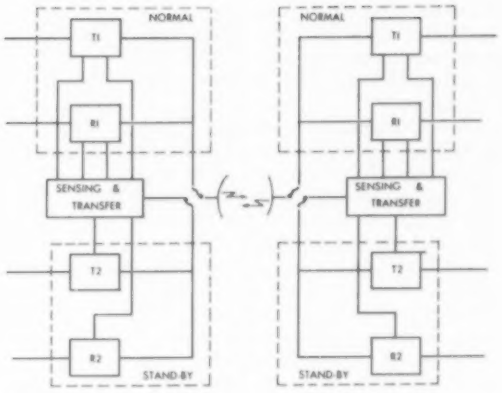

FIG. 5. Typical standby configuration.

which also provides filtering of the carrier and service units.

Modulation amplifier. The modulation amplifier of the UA-6 microwave equipment is utilized to amplify and combine the supervisory and composite baseband signal, composed of the various subcarrier transmitter signals. Output of the modulation amplifier is applied to the repeller of the transmitter klystron and provides direct frequency modulation of the microwave carrier.

The two amplifier stages of the modulation amplifier have sufficient feedback to minimize distortion and variations in gain, as in the case of the baseband amplifier.

RF head assembly. The next few paragraphs describe the RF equipment assembly, which consists of the transmitter and receiver waveguide circuitry. (See Fig. 1.)

Output of the transmit baseband amplifier is applied directly to the repeller supply of the transmitting reflex klystron, which causes the 6000-mc carrier to be frequency modulated. Use is made of a low power (100 mw nominal) reflex klystron, which was specifically designed as an FM source for microwave relay links. As there is no problem of heat dissipation associated with this tube, the use of blowers is not required; however, in order to provide for even greater frequency stability, the reflex klystron is enclosed in a small thermostatically controlled oven that maintains the ambient about the tube almost constant. This practically eliminates any change or variation in the transmitter frequency due to thermal effects.

Continuing its passage toward the antenna, the FM carrier then passes through the transmit isolator, which is a unilateral waveguide transmission device that permits electromagnetic energy traveling in the forward direction (klystron to antenna) to pass with negligible attenuation whereas energy traveling in the reverse direction is greatly attenuated.

By placing the isolator between the reflex klystron and the remaining waveguide components it is not affected by reflected energy due to mismatches or other external effects. Effects of such mismatches, which can be quite serious, are "pulling" of the transmitter klystron, resulting in modulation distortion.

Reduction of these effects is accomplished with an absorption type ferrite isolator using a single coated ferrite strip and integral permanent magnet. Operable over the entire equipment range, the isolator exhibits a forward loss of less than 0.5 db while possessing greater than 30 db of isolation.

Beyond the transmit isolator is the RF discriminator section containing the transmit AFC cavities, transmit frequency monitor cavity, and external transmitter frequency monitor. These units provide automatic microwave carrier frequency control and monitoring.

Activation of the transmitter AFC circuits is initiated by a signal derived from the RF discriminator. Dual, precision cross-coupled tuned-cavity crystal detectors, balanced at the operating frequency, constitute this discriminator. A similar type of tuned cavity detector is utilized for the transmitter frequency monitor. This monitor, in association with its metering circuit, is utilized for tuning and alignment purposes.

The two-cavity band-pass transmit filter, which has a 3-db bandwidth of approximately 20 mc and steep skirt rejection, permits multiplexing of additional transmitters and receivers on a common waveguide system. A manual cutoff switch (capacitive detuner) is included in the output filter section, which enables one to disconnect the transmitter from the circuit during testing and maintenance.

The phaser unit (line stretcher) is inserted between the transmit and receive filters to provide proper coupling (impedance matching) of the main transmit and receive waveguide assemblies. The duplexer tee, in conjunction

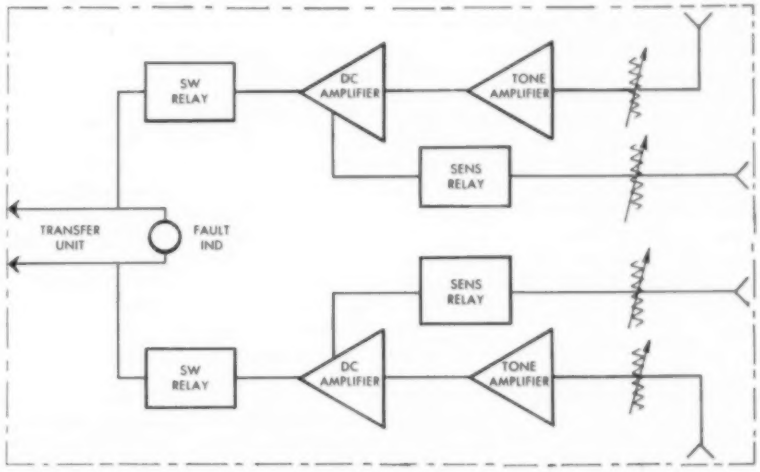

FIG. 6. Block diagram of sensing panel.

with intergral fixed phasing elements, provides low-loss matching of the transmitter and receiver to the common waveguide bus and to other RF equipment for diversity or standby operation.

A pre-selection, four-cavity bandpass filter, having a 3-db bandwidth of approximately 30 mc and steep skirt rejection outside the passband, provides the initial selectivity of the receiver. Attenuation characteristics of the receive filter provide sufficient pre-selection to prevent adjacent channel interference or local oscillator radiation. In addition, it allows for the connection of other transmitters and receivers to a common antenna. A manual cutoff switch identical to that in the transmit filter is included for use during testing and maintenance.

The received signal, after passing through the pre-selection filter, is combined with the output of the local oscillator reflex klystron in the RF crystal mixer.

IF strip. Conventional design has been used in the IF strip, which consists of the IF amplifier and the limiter-discriminator sections. This unit amplifies the intermediate frequency signals produced in the mixer crystal and recovers the composite baseband (video) signal composed of the various subcarrier signals. The IF strip is mounted above the RF panel, with its input connector directly in front of the mixer crystal output.

The IF strip consists of low-noise cascode input amplifier followed by stagger tuned pairs. The first two pentode amplifier stages have automatic gain control (AGC) and are followed by four pentode-amplifier stages, an amplifier-limiter stage, and a discriminator.

Bandwidth of the IF strip, as measured to the grid of the amplifier-limiter stage, is approximately 8 mc at the 3-db points and flat to within 1 db at ± 3 mc of the center frequency at 75 mc. Typical IF response characteristics are shown in Fig. 2. Combination of appropriate test points, and the fact that all tuning can be done from the top of the chassis, permits ease in aligning the IF strip. Additional test points, which are provided at each cathode, simplify trouble shooting the IF strip.

The discriminator is designed to provide excellent linearity over a wide band of frequencies in order to achieve the low value of intermodulation necessary in a multichannel system of this type.

Typical IF response characteristics with a superimposed discriminator response are shown in Fig. 3. Shown in Fig. 4 is the typical baseband response as a function of signal frequency, which points up the results of a highly linear discriminator. Automatic frequency control of the receiver is accomplished by sampling the d-c output voltage of the discriminator, which is fed back to the local oscillator klystron repeller supply.

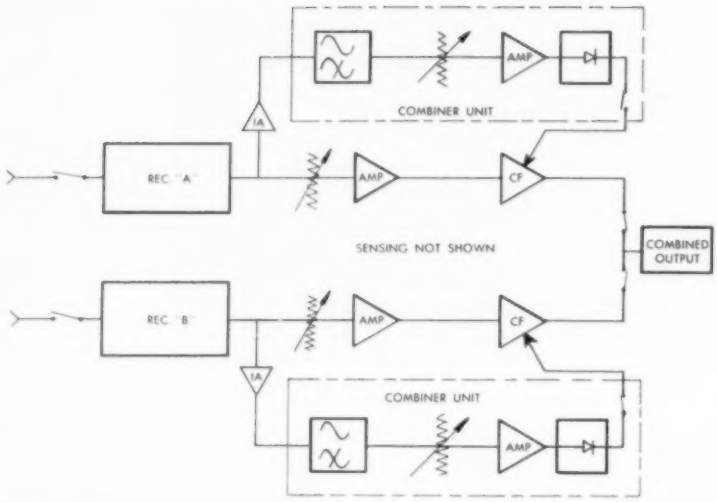

FIG. 7. Two-channel diversity combining.

Automatic frequency control. The AFC unit provides automatic frequency control of the local oscillator klystron and so maintains a constant 75-mc IF frequency. This one-tube unit controls the d-c voltage applied to the repeller of the local oscillator klystron. The tube, which acts as a d-c amplifier, has its control voltage (grid) developed by the discriminator in the IF strip. When the d-c discriminator voltage deviates from zero (indicating on frequency position), a correcting voltage is applied to the repeller by the AFC unit, which returns the discriminator to zero. The AFC can be disabled from the closed servo loop for tuning purposes.

Baseband amplifier. The baseband amplifier is used to amplify the composite baseband signal, composed of the various subcarrier signals or pulses, depending upon the selection of multiplex. The baseband amplifier is mounted in the center portion of the RF panel directly beneath the IF strip. The amplifier input, which is unbalanced, comes directly from the discriminator via a coaxial cable. The amplifier itself consists of two stages of amplification with adequate feedback to minimize distortion and variations in gain, and two final stages to provide additional amplification with minimized distortion and also a low impedance source for feeding the multiplex equipment.

Output of the baseband amplifier is applied to the multiplex equipment at terminal stations. At a repeater station the output is applied to multiplex equipment, when required, and to the modulation amplifier at the other side of the repeater.

Baseband order wire equipment. This unit is completely transistorized and provides a service channel facility for the microwave system. In general a telephone channel meeting EIA Standard TR-141 for voice channels is provided. It includes all equipment and circuitry required between the receive and transmit multiplex basebands and the serviceman's telephone set. A 2-wire telephone circuit is used and provision is made for addition of a 2-wire telephone extension. The unit is adaptable either to a microwave terminal or microwave repeater, which may be a 2, 3, or 4-way station. Optional monitor amplifier and speaker are self-contained.

At a repeater station the service channel unit bridges both directions of transmission, so that the serviceman listens and talks in both directions simultaneously.

The service channel normally occupies the physical channel, 0-3 kc, but the basic circuits have a 12-kc bandwidth so that additional voice channels or tone channels in the 3 to 12-kc band could be accommodated by using 12-kc low pass baseband filters and adding a 3-kc filter.

Transfer and sensing unit. This unit becomes a part of the system when the standby equipment for improving reliability is incorporated (Fig. 5). As shown in the block diagram in Fig. 6, the sensing unit contains detecting circuits to indicate the failure of any active circuit in the system. The monitored items include:

1. Transmitting klystron power output.
2. Local oscillator klystron power output.

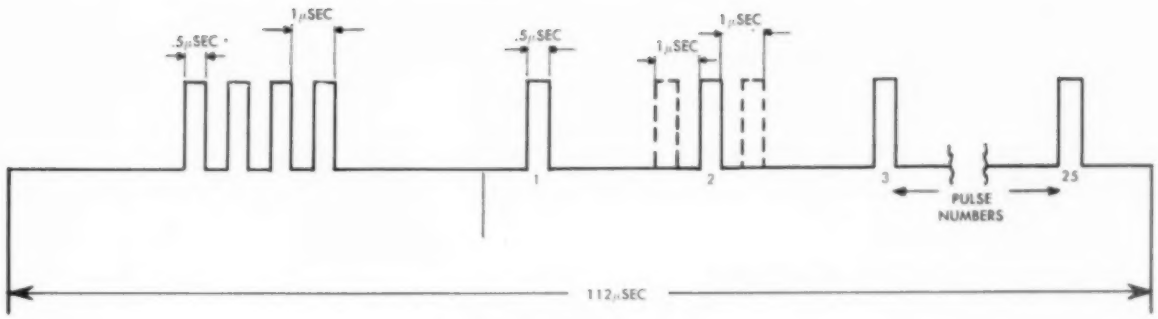

FIG. 8. Composite multiplex signal.

3. Test tone through the modulation amplifier.
4. Test tone and noise through the IF strip and baseband amplifier.

When a fault is detected in any of the four sensing circuits an indicator lamp lights on the face of the unit, remote alarms are actuated if desired, and transfer to a standby system is initiated.

Diversity control unit. When system requirements call for the use of diversity equipment both transmitters are modulated simultaneously with carrier and supervisory information. In this method of operation the receiver outputs are combined in a manner to allow the information content of the two receivers to add in phase or on a voltage basis, while the noise adds on a random or power basis. Thus the signal-to-noise ratio through the combiner is improved up to 3 db over that of a single receiver when the signal strength to the two receivers is the same. In addition, a decrease occurs in intermodulation distortion products by an average of 3 db, because the distortion created in the two different systems is generally random in nature and not in phase.

Combining is accomplished at the output of the baseband amplifiers by tying the CF amplifier outputs together without d-c isolation. Thus, total plate current is constant regardless of the output of individual tubes. By sampling the noise level of the two receivers it is possible to select individually the best receiver at all times by biasing the noisy receiver baseband amplifier in a more "off condition" as the noise level increases. Hence, as the output level remains constant and the noisy receiver is being turned off, the signal-to-noise ratio is improved.

Both circuits contribute signal to the output at all times, but the degree of contribution is established by the relative noise levels of both receivers. In the event of a complete receiver failure, that receiver is biased completely off and an alarm given to indicate the failure. Shown in Fig. 7 is a block diagram for 2-channel diversity combining.

Multiplexing

As mentioned, the 6-kmc (UA-6) equipment will accommodate both time division and frequency division multiplexing. The method of multiplexing, just as the choice of RF carrier frequency, deserves serious consideration in system planning. Both methods of multiplexing offer system planners great flexibility.

Basically the time division and frequency division systems are quite distinguishable. In the case of time division multiplexing, many channels are propagated over a common medium by assigning different time intervals for the transmission of each signal. Each channel, therefore, uses the entire frequency spectrum of the system.

Looking at this approach in another way, time division multiplexing may be regarded as a kind of phase discrimination wherein the information bearing signal of a particular channel is modulated on harmonic carriers. These carriers are so phased as to balance out interchannel crosstalk during time intervals alloted to that channel. In this system, very short samples of the speech wave in each channel are taken successively and transmitted. After one set of samples of all the channels has been transmitted, another set is taken and transmitted, and so on continuously, set after set. Therefore, at any one instant, only one of the speech wave trains is displayed by the transmitted signal.

In the case of frequency division multiplexing, a number of channels (different information-bearing signals) are propagated simultaneously over a common path by using different frequency bands for the transmission of each signal. In other words, this means that a band of relatively high frequencies is divided into a number of narrower bands, each of which serves as a channel. In the composite baseband, frequencies representing all channels may be present at all times, therefore the name "frequency division multiplex."

Fig. 8 shows one frame of the composite multiplex signal for a time divsion system using pulse position modulation. In order to transmit information, the various channel pulses are modulated by the presence of an audio modulating signal, which causes the channel pulse to be formed earlier or later during this time space. Maximum deviation from the center position is limited to $\pm$ 1.1 microseconds with the nominal 100 percent modulation being $\pm$ 1.0 microseconds. By interleaving a negative train of 25 pulses with the positive train shown in Fig. 8, 50 voice channels of time division can be transmitted over the UA-6 system.[4]

For a system requiring large channel capacity the 6-kmc system with (FDM) is recommended; however, when the channel capacity requirements fall within the realm of the time division equipment, the decision as to choice of system requires additional consideration.

In a situation involving a long haul system (many hops) that calls for only moderate channel loading, it is recommended that the time division equipment be incorporated. This is dictated by the fact that in frequency division systems the intermodulation distortion is cumulative in going from hop-to-hop, whereas in time division systems there is no such addition.

It is impossible in an article of this length to discuss every situation that might arise. Serious attention should be given to the choice of system, however, as there are many factors involved. Some of these are: (1) Channel capacity; (2) frequency allocation; (3) length of system; (4) transmitted information, and (5) expansion needs.

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★ ★ ★

SPECIAL REPORT
PIPELINE COMMUNICATIONS AND CONTROL

To date, most controls are of the "automatic sequence" variety, but already designed are systems that do not require manual initiation

SOON . . . AUTOMATIC CONTROL WITHOUT THE BUTTON PUSH

Edgar N. Sampson, *Controls Engineer*
The Cooper-Bessemer Corporation

AUTOMATIC SEQUENCED COMPRESSOR UNITS started by the push of a button are now in service. The next step is automatically controlled units that don't even require the push! In reality, this step is almost here. Control systems have already been designed that do not require a manually initiated starting signal or running control!

Among gas pipeline and controls people, a unit that can be properly started by actuation of a pushbutton or turning of a selector switch is considered as having "automatic sequence control"; one that starts from a set point, or predetermined condition occurring without actuating a pushbutton is considered "automatic."

To date, the majority of controls in use or in the planning stage are of the "automatic sequence" variety. The question asked most often — and one that excites the most interest — seems to be *"How far away can I be to push a button and still have complete, dependable control?"*

An approach has been made to the problem of pipeline automation with the basic question of *"What is a 'sound' control system?"*

The answer, at present, is a system that will properly sequence the engine unit and the associated equipment as well as protect the equipment adequately and from *any* location. Whether the initiating signal is right at the equipment, in an engine room, a control station 200 ft away, or in the next state, is a matter of choice.

A sound control system should be flexible so that any desired sequence can be followed. The circuitry and components should be serviceable without requiring extensive training for service personnel. The end product, of course, must be competitive with present systems.

Basically, all gas engine-compressor units are started in the same pattern—line valves are positioned for starting, the engine is rolled, ignition and fuel supplied, the rolling force removed, line valves positioned for load, and engine speed adjusted.

From this, two basic needs are obvious—the positioning of line valves before and after starting, and the control of the engine during starting and operating.

To be adequate, the two control systems must, of necessity, be interlocked for proper sequence. Then there is the requirement of safety protection. There are certain malfunctions that can be tolerated for a period of time without requiring shutdown. Other malfunctions require immediate shutdown to prevent damage. Consequently, safety and alarm circuits must be interlocked for proper sequence control to obtain proper protection.

In pipeline compressor control, four basic circuits are involved:

1. **Engine control**
2. **Line valve control**
3. **Alarm notification**
4. **Shutdown protection**

A prime question in the matter of controls is the control medium itself. Should it be air? Oil? Water? Gas? Electricity? Usually, the choice is a combination of mediums.

Engine Control

Most engines are started or rolled with air. To control starting air is a relatively simple problem involving an air valve and some means of signaling required operation.

A three-way solenoid generally is used to control the starting air valve, admitting control air when energized and venting when de-energized. Admitting control air to the starting air valve opens it, allowing air to the engine.

For ignition control, the conventional ignition switch is replaced with a relay.

Fuel gas is controlled in the same manner as starting air. To allow for shutdown, however, the fuel gas valve is a three-way unit to vent the gas manifold.

The basic problem in engine starting is to determine how to initiate sequence of starting air, ignition, and fuel gas.

An engine starting sequence can be initiated by a pushbutton switch operated locally or remotely to energize a relay, which in time can lock in and

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energize the starting air control solenoid, admitting air to the engine cylinders. The purge time relay energizes engine ignition. The ignition relay then energizes the fuel gas control solenoid and gas is admitted to the engine cylinders.

Need for sensing engine rolling also is necessary. A built-in lube oil pump, jacket water pump, or scavenging air pump delivers a pressure while the engine is rolling on air. Consequently, any of these pressures can be sensed by a pressure switch to indicate the unit actually is rolling on air. The pressure switch energizes the purge time relay, which in turn gives a set time of air rolling to purge the engine cylinders thoroughly.

At this point, two more problems confront the control designer:

1. Gas admitted at full fuel pressure at rolling speed will stall the engine or lift the cylinder heads off the engine.
2. Starting air must be shut off, if engine is running on gas.

The first problem is solved with a pneumatically operated governor adjusted to an "idle" setting. At startup, a solenoid valve in the control air line will bring the governor to "idle." The governor must be of pneumatic type to take advantage of available or "condition" controls.

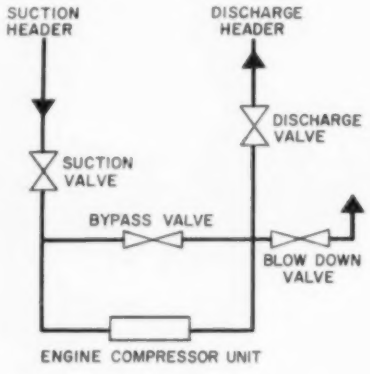
For the second problem, the engine idles faster than it rolls on air, so a second pressure switch — sensing a resultant increase in oil, water, or air pressures — is used to de-energize the starting air control solenoid. By using a relay in conjunction with this second pressure switch, "idle" control can be established to allow the engine to come under governor control. The engine is now started. Speed can be simply regulated.

Line Valve Control

Considering suction, discharge, bypass for the compressor unit, and blow down, elimination of, or a change in, any of the line valve functions can be accomplished easily.

Sequence of line functions can be:

1. **Close blow-down valve**
2. **Start engine and bring under governor control**
3. **Open discharge valve**
4. **Open suction valve**
5. **Close bypass valve**



Various types of valve operators are available that, upon receiving the proper signal, will open or close the valve. These operators can be pneumatic, hydraulic, electric, or a combination.

Following the sequence suggested, the first step is to close the blow-down valve. Actuating the pushbutton energizes a relay that energizes the "close" circuit of the blow-down valve operator, closing the blow-down valve. A limit switch at the end of the blow-down close travel initiates engine starting.

With the blow-down valve closed and the engine running, a relay is used to obtain governor control. This same relay is used to key the actuating circuit of the other unit valves. More than one additional relay can be used to do the keying on whatever sequence is required. The engine is now running and loaded.

Alarm and Safety Shut-Down

For protection of all the equipment, commercially available alarm and shut-down circuits can be used or units specifically designed for the job.

Sensing switches for alarm condition of temperatures and pressures can be installed on the engine and in the piping, including checks on lube oil pressure (low), jacket water temperature (high), fuel pressure (high or low), and control air. These and other conditions are monitored for safety.

The basic alarm circuit incorporates a sensing switch, a relay to key a horn, an indicating light to indicate the particular malfunction, and a relay to acknowledge and silence the horn. The complete alarm circuit has provision for testing the individual relays and lights for correct operation for each alarm indicating point.

Switches for shut-down condition of temperatures and pressures also can be installed on the engine. These may be incorporated with or without alarms. Overspeed protection is provided by governors having a switch or linkage arrangement. Operation of any of the shut-down switches will stop the engine and properly position the unit valves.

Normal Shut-Down

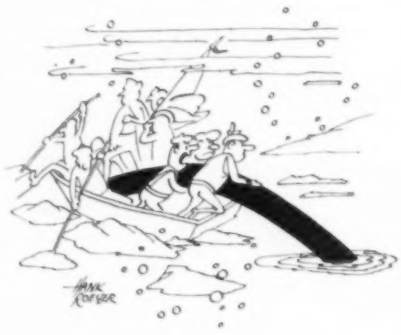
Normal shut-down is initiated through a second pushbutton. By means of interlocked relays, the line valves are positioned, suction and discharge closed, bypass and blow-down opened, and the engine stopped by de-energizing the fuel gas control solenoid after a "cooling" period.

For service around gas compressors, electrical equipment must be enclosed in explosion-proof housings. If the control panel housing the relays, indicating lights, and switches can be removed from the hazardous area to a control room, standard construction with standard parts can be used. Only the **"on engine"** sensing switches, solenoids, and ignition relays then need be of explosion-proof construction.

By using limit switches and other sensing switches, indicating lights can be triggered to indicate progress of the sequence. By substituting relays for hand switches, the control system can be arranged to allow for extremely remote operation. ★ ★ ★

The Author

Edgar N. Sampson, *controls engineer for The Cooper-Bessemer Corporation, joined the company in 1953 as an electrical engineer. His engineering experience from 1949 until that date was with Dayton Malleable Iron Company, Ironton, Ohio, as supervisor of electrical maintenance and construction of the company's foundry. He was graduated from Ohio State University in 1949 with a bachelor's degree in electrical engineering, and is a member of the National Association of Professional Engineers and the American Institute of Electrical Engineers.*



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MICROWAVE OCCUPIES A KEY POSITION IN PIPELINE OPERATIONS

Paul A. Smith and Lee Weddig
Technical Information Center
Motorola, Inc.

ONLY A DECADE has passed since the birth of petroleum industry microwave communications. Nevertheless, this mighty infant has assumed a tremendous workload and has grown in capability, flexibility, capacity, and acceptance with giant strides.

Growth of microwave was a natural evolution of wireline communications media. As the requirement developed for more communications facilities, carrier equipment permitted combining many communications over a single wire line by use of multiplexing techniques — combining many channels of intelligence at the sending end, separating them at the receiving end. Using a narrow, highly directive radio frequency beam instead of wires was the next step.

This development of microwave techniques, especially in the 6000-mc frequencies, took place after World War II. Efficient, successful microwave communications have resulted with many systems in the pipeline and petroleum-gas operating areas carrying three to more than 20 channels of intelligence.

Typical of recent technical growth were announcements by one manufacturer (Motorola) of further refined microwave products in new MR-20 RF equipment and MC-20 48-channel multiplex equipment.

RF Microwave Equipment

Basically, the RF portion of a microwave system provides the carrier for various signals carrying the communicated intelligence. As an example, we will discuss the new Model MR-20, one of the newest equipments to make its debut.

Operation is in the region of 6000 mc. Carrier frequencies of the order enable the use of compact high-gain, highly directional antennas, and practical passive reflectors. The high efficiency of this design permits operation at a conservative power output and thus enhances equipment performance reliability. In addition, there are no electrical or mechanical connections between the tower with its top-mounted passive reflectors and the microwave equipment itself. This feature eliminates the necessity for tower climbing and reduces the danger of lightning damage to equipment.

A further advantage accrues from the use of tower-mounted passive reflectors. Since the carrier frequency energy is emitted upward from a parabolic reflector at the base of the tower, and is then reflected to a horizontal path by the 45-deg passive reflector, transmission line loss from the transmitter to the top of the tower is eliminated . . . not only is such loss eliminated, but because the passive reflectors are slightly curved rather than being flat, an additional 3 to 8 db gain is realized.

The equipment is designed to provide multiplexed communications unaffected by storm, ice, rain, snow, or magnetic disturbances, and consists of those elements necessary to generate and modulate one microwave RF carrier, and to receive and demodulate a second carrier.

A reflex klystron is utilized as the RF generator, and a similar reflex klystron as the local oscillator of the receiver. Output frequency of the reflex klystrons is determined by grid spacing and, to a lesser extent, by repeller plate voltage. Grid spacing is controlled by an adjustment on the tube. These mechanical adjustments are connected to the control panel tuning knobs by an improved system of couplings, gears, and shafts specifically designed and tested to eliminate backlash and provide more positive tuning control.

Silicon rectifiers are the heart of the power supply, replacing selenium rectifiers. With the availability of silicon rectifiers, the power supply was redesigned and equipment now occupies less space, weighs less, and has fewer component parts.

To facilitate tuning, adjustments, and routine checks of the microwave equipment, all controls are mounted on one panel.

Frequency Diversity

Instances may arise in which layers of still air between microwave stations will cause two-path propagation of the carrier signal. If the path lengths are not equal, the resulting two signals will arrive somewhat out of phase, with consequent signal degradation. That is to say, under such conditions, fading would occur. A study of microwave propagation, however, reveals that fading does not occur at the same time on two widely separated frequencies. Thus, if two widely separated carriers having the same modulating informa-

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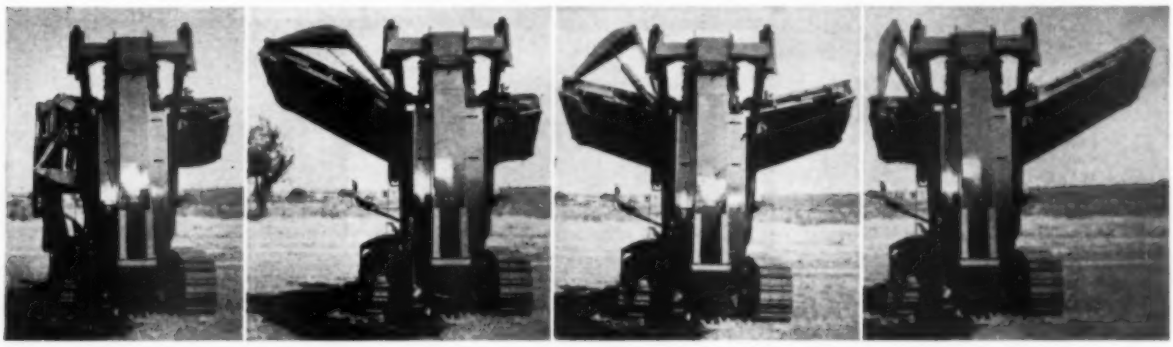

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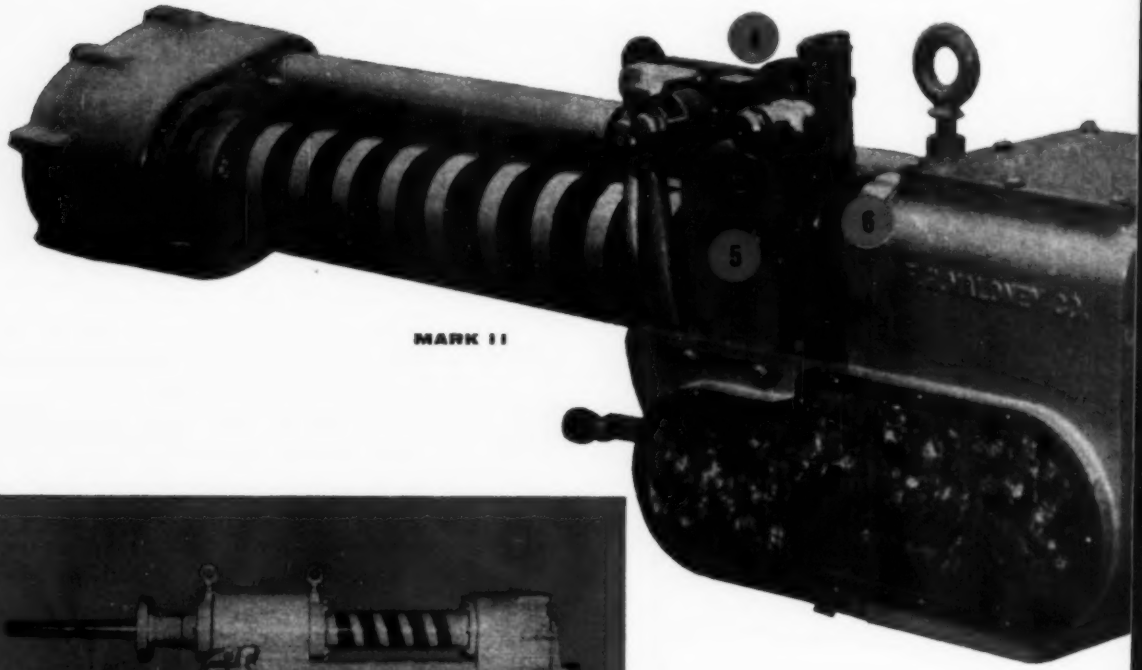
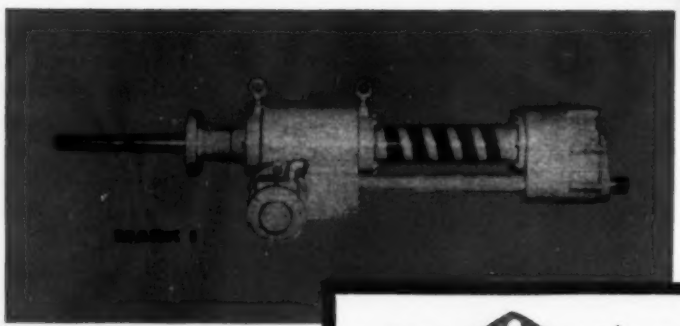
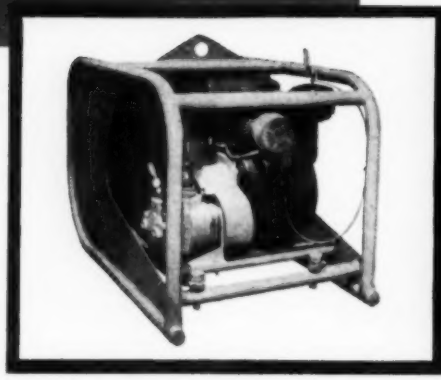
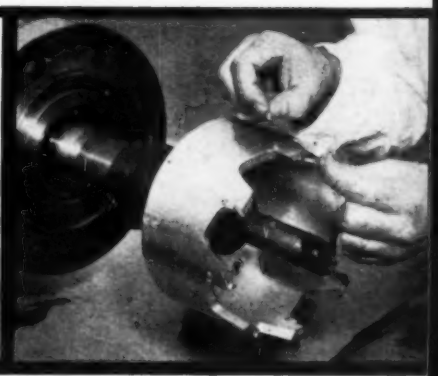




Based on the same design as the MARK II, the MARK I covers the range of high pressure taps from 1 inch to 6 inch. Available with air motor or hand crank operation, the MARK I is rated at the same operating pressures and temperatures as the MARK II. Twist drill cutters are available to 3 inch, shell type cutters to 6 inch. (MARK I Air Requirements 90 psi, @ 105 cfm.)



Companion Hydraulic Power Unit powered with 9 hp gasoline engine, completely self-contained. Provides ample power and positive control of cutter torque with calibrated, infinitely variable, flow control. Available as an accessory with the MARK II. (MARK II Air Requirements — 90 psi, @ 105 cfm.)



Completely new shell cutter design — exclusively Maloney — provides instant field change of teeth, pilot, and cutter components *without* special tools or handling.

Pipe Tapping Machines

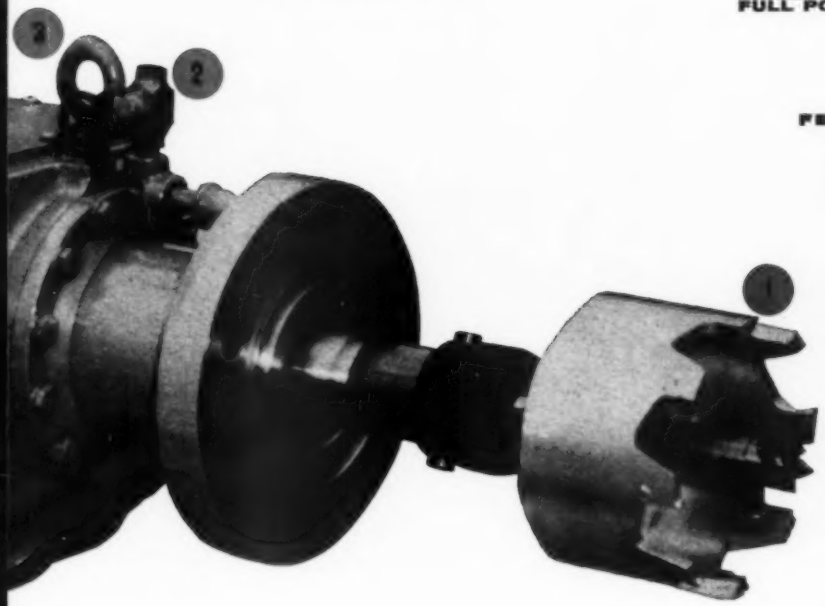
Maloney

MARK I

1 to 6 inch
air or hand crank

MARK II

4 to 16 inch
air or hydraulic
FULL POWER OPERATION



FEATURING

1. Revolutionary shell cutters provide cleaner cutting with less torque. Replaceable teeth, shell, and backplate for field maintenance.
2. Integral bleed-off valve.
3. Center of gravity well forward, near the cutting end of the machine, for easier handling. Vertical and horizontal operation with built-in lifting rings and bail.
4. Air or Hydraulic power (MARK II only), with ample reserve power. Completely reversible—makes the *full range* of cuts without alteration.
5. All operating controls grouped for simple operation.
6. Boring bar travel counter (MARK II only) measures travel in .01 inch increments. No guessing where the cutter is.
7. Simplified design eliminates unnecessary maintenance. Designed to be operated and maintained by *your* operating personnel.

New
"Something From the Irishman"

F. H. Maloney COMPANY

Post Office Box 1777 • Houston 1, Texas

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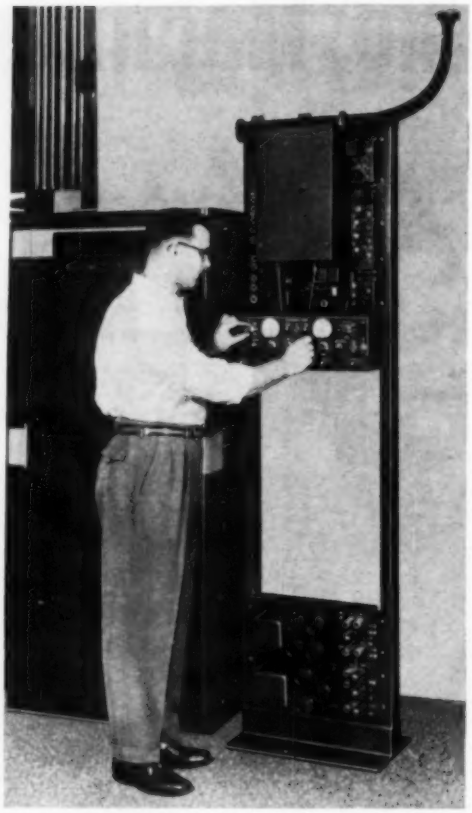
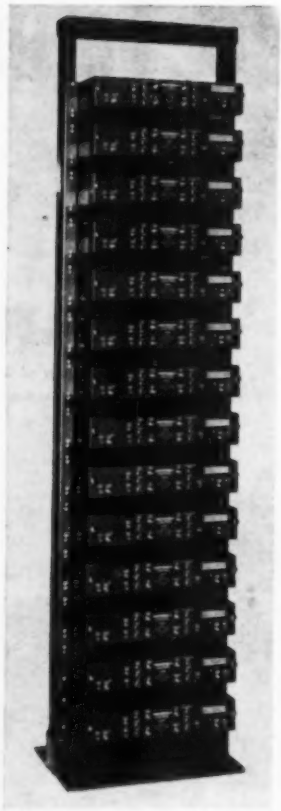
tion are transmitted simultaneously, the stronger can be selected at the receiver, and communications will be maintained. This type of operation is called frequency diversity.

There are communications systems that cannot tolerate interruptions even of short duration. MR-20 frequency diversity microwave equipment is designed for such requirements. It should be noted, however, that current FCC regulations limit licensing of frequency diversity systems.

In areas subject to fading, frequency diversity communications offer a better solution than space diversity installations. At a frequency diversity terminal station, two racks of basic microwave RF equipment are required. In addition, the terminal station will require a frequency diversity sensing panel, a signal comparator frame with two pilot channel receivers and one pilot channel transmitter, a transmitter sensing unit, and a power supply chassis. A frequency diversity repeater station basically consists of two terminal stations back to back except that no pilot channel transmitters are necessary.

In a frequency diversity system, both units are operating simultaneously on two widely separated frequencies and both are continuously transmitting the same intelligence. A signal comparator monitors the signals at the receiver end, and the stronger signal (by a predetermined difference) is connected to the multiplex termination equipment.





Left — Engineer makes fine adjustment on microwave RF equipment.
Right — Each terminal of the multiplex equipment contains subcarrier transmitter, receiver, frequency controlling units, a signaling subchassis, audio termination subchassis, and power supply.

"Hot" and "Cold" Standby Systems

A MR-20 microwave system may be equipped for either instantaneous (hot) switchover to a standby transmitter-receiver combination at any station, or for delayed (cold) switchover. With such an installation, the equipment is monitored continuously for any circuit malfunction. The failure sensing circuit acts as the "trigger" that initiates the switchover action.

Hot standby systems use two bays of equipment, both of which are powered and operative at all times. The antenna circuit is common to both bays, and is switched from one to the other as required. Cold standby systems also use two bays of equipment, but only one bay is powered. Use of cold standby provides a saving in power consumption and involves a delay of only 45 seconds in switchover.

Two different switchover panels are available, one for cold switchover, the other for hot switchover. Cold switchover is a unilateral operation that permits switchover automatically from the main RF bay to the standby bay, but does not switch back automatically. The switchover panel associated with hot standby equipment provides for bilateral switchover; operation may be switched interchangeably and automatically from one RF bay to the other. Controls are provided to permit manual switching so that switchover circuits may be checked and tested. Standby equipment may also be energized and tested without connection to the antenna.

The microwave equipment under discussion features a newly designed waveguide manifold permitting paralleling of up to four bays while using the original antenna system.

As mentioned, the heart of the microwave transmitter is the reflex klystron, an electron tube that contains its own oscillatory circuit and is used to generate the microwave carrier signal in the vicinity of 6000 mc. A characteristic of the reflex klystron is that the frequency it generates may be varied directly by varying the voltage applied to the repeller plate, an electrode of the tube. Consequently, the tube is inherently capable of being frequency modulated by the output of the subcarrier transmitters, whose signal previously has been modulated to carry the desired intelligence.

As the microwave carrier signal is a broad band signal, it can be modulated with a large number of subcarriers. This process, of course, is known as multiplexing.

Multiplex Equipment

The MC-20 multiplex operates on FM subcarrier frequencies in a baseband of 200 kc to 1 mc. This provides 48 sub-carrier channels with center-to-center separation of 16 kc. A subcarrier channel exists when a remote receiver is tuned to the subcarrier frequency generated by the multiplex transmitter. The multiplex receiver is not affected by subcarrier frequencies other than the one to which it is tuned.

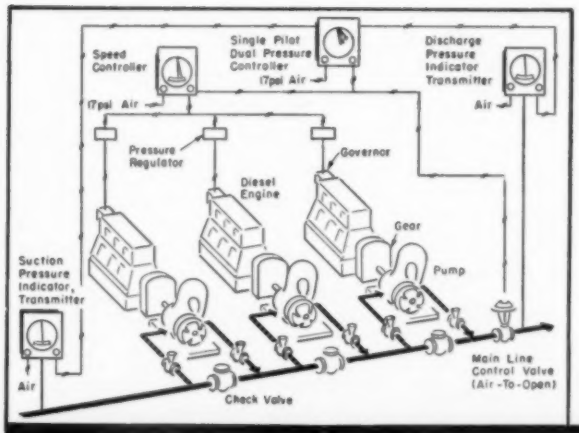
The multiplexing equipment is the result of research having the following goals:

1. Development of standardized multiplex assemblies incorporating a high degree of flexibility in their application to terminal facilities.

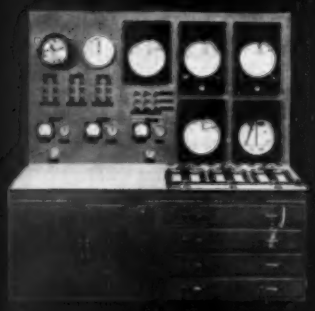
2. Elimination, as much as possible, of auxiliary chassis.

3. Complete independence of individual subcarrier channels.

U. S. planes in Spain fueled by 485-mile pipeline



Honeywell controls automatically balance suction and discharge pressures at each of six pumping stations. If the suction or discharge pressure deviates from the set limits, the pipeline is automatically protected in two ways. The decreasing pressure output from the single-pilot dual pressure controller lets the valve close . . . causes the speed controller to slow down the engines if the decreasing signal drops below the speed controller set point.



Pumping stations No. 1 through No. 5 have Honeywell control consoles with graphic panels. In addition to the necessary temperature, pressure, flow and speed recorders and controllers, each console contains a complete alarm system to protect workers and equipment.

The use of standard off-the-shelf instruments on this control console for Station No. 6 and the other five consoles simplifies maintenance . . . gives the flexibility needed for easy expansion.

Line is automatically controlled by Honeywell instrumentation

A pipeline that extends almost the full length of the Spanish peninsula carries jet fuel and aviation gas to U.S. Air Force bases. Honeywell instrumentation serves four basic functions in the line: running control, measurement, safety, and start-stop control.

The six diesel-powered pumping stations that keep fuel flowing are equipped with semi-automatic starting and automatic running and stopping control. A graphic console is the control center for each station.

Throughout the entire system, design emphasis is on standard, off-the-shelf equipment and minimum maintenance—in keeping with military requirements. And while the system is quite simple in comparison with the more highly sophisticated remotely-controlled pipelines in service today, it provides the maximum in automatic, economical control. Moreover, its extreme flexibility allows for simple expansion.

Honeywell, world's largest maker of controls, is the logical source for your own instrumentation needs. Call your nearby Honeywell field engineer today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

H HONEYWELL *First in Control*

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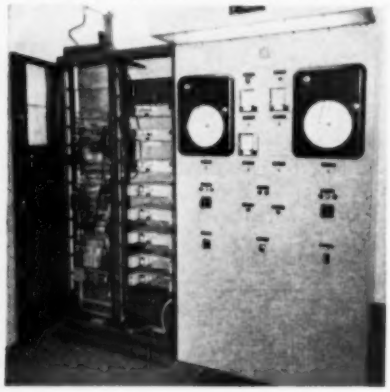
Transmitting

From its office in Gainesville, the Georgia Gas Company controls an Ingersoll-Rand SVG gas-engine compressor 15 miles away by microwave signals. This control panel indicates operating conditions, and contains con-



trols which are linked by the microwave transmitter (at its left) to a receiver and control panel at the compressor station 15 miles away (see opposite page).

Ingersoll-Rand
6-894

4. Simplified test and adjustment procedures, and avoidance of any requirement for highly specialized test instruments.

5. Extension of applications of multiplex equipment to terminal facilities of all existing types plus future adaptation to as-yet unspecified requirements by means of minor modifications.

6. Continuation of quality voice transmission.

7. Increased reliability by the use of newly-developed components.

A channel terminal of the multiplexing equipment is a relatively small assembly, but it contains a subcarrier transmitter, subcarrier receiver, power supply, audio termination subchassis, and a signaling subchassis. Up to 15 such assemblies may be mounted on a standard 19 in. wide, 7 ft rack.

Subcarrier transmitter design consists of five stages in three tubes to perform the following functions: (1) Generate a frequency-modulated signal when modulated by audio signals between 300 and 3000 cps; (2) shift the frequency of the subcarrier down 4 kc when signaling voltage is applied to the modulator input circuit, and (3) provide keyed carrier operation.

The subcarrier receiver circuit is composed of a two-stage input amplifier, an RF filter section, a mixer, a local oscillator, the factory-tuned and permanently sealed Permakay filter, a 150-kc IF amplifier, three limiter stages, a discriminator, and an audio output stage.

The highly standardized and flexible basic channel terminal may be put to a wide variety of uses among which are:

Telemetering, teletypewriters, supervisory control

Dry line, AC ringdown, push-to-ring, duplex private-line telephone

Wet line, AC ringdown, magneto, simplex party or duplex private-line telephone

Loop dial, (phone end), dial signaling

Loop dial, (switchboard end) dial signaling

DC ringdown, push-to-ring, simplex party or duplex private-line telephone

E and M ringdown

Selective dial, simplex push-to-talk, party line telephone

VHF radio control, local (console) end

VHF radio control, remote end

Intertoll dial

Dry line, AC ringdown, push-to-ring duplex party line telephone

Wet line, DC ringdown, push-to-ring duplex party line telephone

The basic channel terminals that may be used to accomplish any of the above functions differ between themselves only in the type of signaling subchassis (a small relay unit) installed, and in the interconnection of the signaling subchassis with the built-in audio termination subchassis.

In order to provide for duplex party line telephone service at repeater stations over a microwave system (and so furnish a conference type of party line service), two specialized channel terminals have been developed. These are the drop and insert channel terminal, and the heterodyne channel terminal. When these channel terminals are installed, several persons at various points on the line are enabled to converse simultaneously.

Although the receivers, transmitters, and power supplies of these two specialized channel terminals are alike, other circuitry and components differ. In operation, the drop and insert channel terminal demodulates the incoming signals to audio before retransmitting them, whereas the heterodyne channel terminal does not. The latter channel terminal provides for the simultaneous transmission and reception of the subcarrier signals in both the "east" and "west" directions; for this purpose, the signal on the video bus between back-to-back microwave equipment remains at the intermediate frequency of the microwave equipment.

Dialing pulses are transmitted over the microwave system by shifting the subcarrier transmitter frequency 4 kc downward periodically as dialing pulses are applied to the subcarrier transmitter. Dial pulses received (in this form of frequency shift keying) by the remote subcarrier receiver are fed into an exchange in the form of circuit interruptions and will operate telephone switching equipment to select a specific line.

Normal metering is done with a portable meter kit; the kit is constructed in a cubical metal case 2½ in. on a side. It consists of a meter, selector switch, and the necessary resistors. The meter is intended for observation of the subcarrier receiver limiter circuit and discriminator circuits, subcarrier transmitter output, and for measuring B+ voltage. The meter case is provided with an octal plug, which allows the instrument to be inserted into the octal socket found on the front panel of each channel terminal. ★ ★ ★

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The IR gas-engine compressors that "THINK FOR THEMSELVES" also respond to

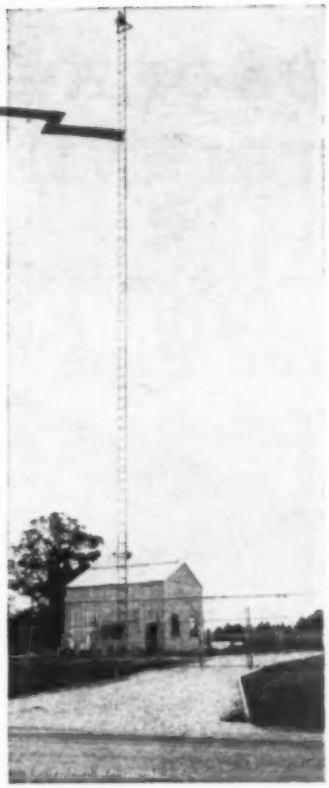
"TELEPATHY"

...Georgia Gas Company's new booster station is controlled by microwave from 15 miles away

At Georgia Gas Company's office in downtown Gainesville, a man turns a knob on a control panel and a radio signal is beamed from a tower outside the building. Fifteen miles away, a 440-hp Ingersoll-Rand SVG gas-engine compressor plant starts itself, brings itself up to speed, and puts itself on stream delivering gas to Georgia homes and businesses. All the time it is running, the unit is monitoring its own operation and protecting itself from harm.

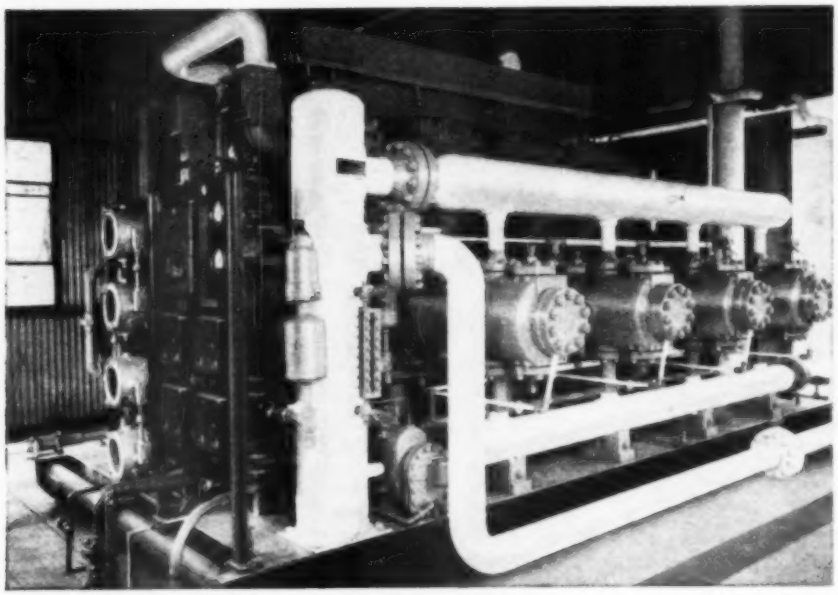
This installation is only a sample of the new things happening in the pipeline field, and this SVG is only a part of the Ingersoll-Rand compressor family that is meeting the challenge of new developments. I-R 4-cycle V-angle engine-compressors are ideal for automated and remote-control installations, due to inherently greater operating *stability* through a wide range of speeds and loads.

Ingersoll-Rand has supplied millions of horsepower of heavy-duty compressors for every possible service, and builds many types of other equipment for the pipeline industry. Call your I-R representative now for more information.



Receiving

Radio signals received by this panel are converted to impulses which start or stop the Ingersoll-Rand SVG gas-engine compressor shown at left below. With the panel, the compressor automatically monitors its operation—it takes its own temperatures, gauges its pressures, watches its lubrication and protects itself from damage. And if any abnormal condition occurs, it warns its operator and shuts itself down.



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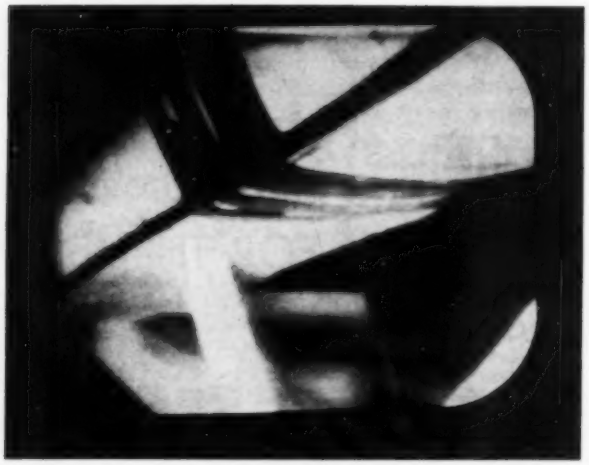
Only I-R compressors have CHANNEL VALVES

Known for high efficiency, quiet operation and exceptional durability. Entirely different. Each valve is a combination of straight-lifting stainless-steel channels and leaf springs, with trapped-air spaces which cushion action, prevent impact.

UNDERWATER TELEVISION —New Tool for Pipeliners



View of television screen showing the pontoons on a pulling sled. Camera was in 300 ft of water.

Closed circuit system has been used successfully to view what is happening during offshore construction

Eldone H. Truex
Arnold Barnes Company
Dallas, Texas

IN ORDER TO PROTECT INVESTMENTS of millions of dollars in offshore equipment, the oil and gas industries are investigating use of underwater television.

One of the more progressive gas transmission companies staged a demonstration off the Louisiana Coast recently to determine whether underwater television could be used to inspect existing facilities, facilities under construction, and underwater pipelines. It was held on an offshore platform 20 miles out in the Gulf of Mexico. Divers unfamiliar with the use of the TV camera were used to handle this new underwater tool.

Underwater TV, first successfully used at the Bikini atom bomb trials, affords a comparatively new and potentially valuable aid in determining the condition of underwater pipelines and platforms. It can also be used to determine the location of pipelines and to see that they are not laid over underwater obstructions.

According to Kin Tel-Underwater Surveys, the equipment used in the demonstration incorporated many desirable features that are innovations in the field. The portable, aluminum underwater housing with camera weighs a maximum of four pounds when it is in use underwater. Two important safety features incorporated in the system are an automatic shutter that closes when the lens iris is set to minimum aperature, to protect the camera eye from direct light, and an indicator light that indicates when excessive moisture is in the system.

Highlight of the demonstration was the observation of the gas pipe riser on the offshore platform. The picture was clear enough at a depth of 30 ft with ambient light to observe the threads on the bolt used to clamp the pipe to the platform. It was also possible to see the space between the pipe and the clamp, a broken weld on the clamp, and the features on the diver's face.

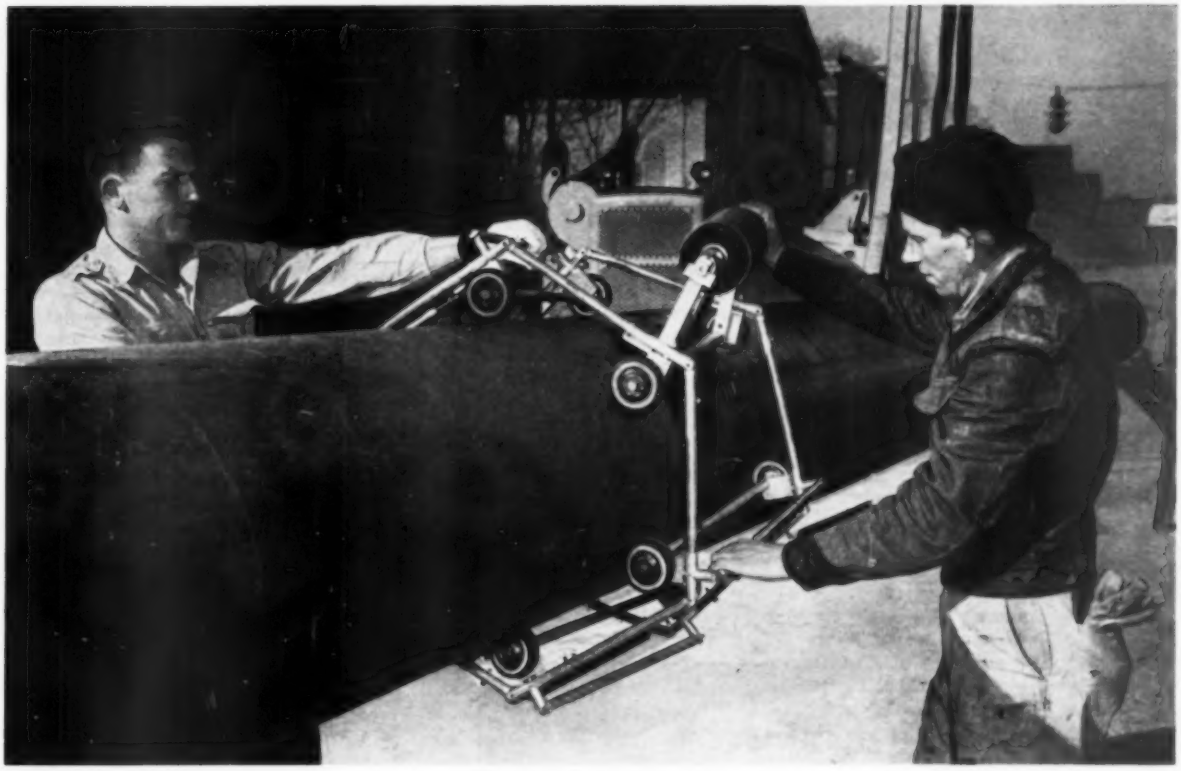
A 2,400,000 candle power light was used to help see when the turbidity level of the water was high. The angle of the light and the camera and their proximity to the subject are all important in obtaining a picture in these adverse conditions. A worthwhile picture can be obtained when these tools are used properly.

Underwater television is not meant to be used as a replacement for the trained, professional diver; however, its usefulness as a means of obtaining

Television camera being lowered off the side of a ship.

THE MODERN TAPE...AT WORK FOR MODERN INDUSTRY

20-inch gas main site-wrapped with versatile Polyken® tape



Upper New York State utility company turns to Polyken tape to get the job done fast...and sure...in congested areas

This is the tape that's making big-inch pipeline news this year. Made of tough, inert polyethylene, Polyken tape offers proven protection against the corrosive effects of moisture, soil chemicals and electrolytic current.

And here, on a site-wrapping job in a congested city area, it provides another major advantage: *simplicity of application.*

Tape saves headaches

You know the complications of using a hot coating in a place like this. Easy-to-apply Polyken tape does away with these problems. It goes on, as you see, right off the roll—without heat, liquids, solvents or thinners. Saves time, labor and equipment costs.

Now you know why more and more utility companies are turning to site or over-the-ditch wrapping for their distribution lines with time-tested, time- and money-saving Polyken tape.

For further information, write to the Polyken Sales Division, 309 W. Jackson Blvd., Chicago 6, Ill.

Polyken®

Experienced in modern PROTECTIVE COATINGS

THE KENDALL COMPANY
Polyken Sales Division

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Components of a typical underwater television system being used by J. Granville of Kin Tel-Underwater Surveys, and E. Cross, professional diver, off a pier in San Diego, California.

underwater information or in directing subsurface operations is practically unlimited. Through the use of underwater television the trained operator or specialist with the aid of a capable diver manning the camera below the surface, can get immediate and complete factual information on which to base his future decision or action concerning the problem at hand, regardless of its complexity.

Joseph D. Granville, a pioneer in the field of underwater television, demonstrated the equipment for Kin Tel-Underwater Surveys. He has had experience in underwater use of TV in drilling oil wells at depths of 1000 ft, the sealing of pipelines at 312 ft, the inspection of missile firings under water, and many other applications. He states that alert engineers are winning competitive advantages for their firms with underwater television. For five years reliable equipment has been available with visual evidence of what is happening below the water line.

What is Underwater Closed Circuit Television?

This system is composed of three components: Camera, camera control unit, and the TV monitor (similar to the home receiver). These units are interconnected with wires and because of this the system is designated closed circuit. The system operates on 110-v, 60 cycles and requires 500 watts. The camera control may be mounted up to 1000 ft from the camera, and the monitor may be up to 1000 ft from the camera control without line amplifiers. Any number of monitors may be fed from one camera, or a number of cameras may be alternately viewed on one or more monitors. Built-in connectors provide for audio intercommunication between camera and camera control if desired.

Underwater systems have been going through many stages of simplification and some have only one adjustment for the camera control unit. Any person who has had the benefit of a short training session can operate the system with success.

As far as the maintenance of a system is concerned, most qualified electronics maintenance men can repair the equipment if they have the proper instruction manuals. Authorized maintenance personnel usually are appointed in an area where a system is to be used for an extended period of time.

Operation of the System Underwater

The television camera is mounted in a housing that can withstand water pressures to depths greater than 1000 ft. This housing can be either a light, portable, aluminum housing for use by divers or a rugged brass housing for a fixed installation application. Fixed housings are used for continuous underwater use. Cameras are equipped with servo motors that operate the focus and iris adjustments. The diver need only point the camera in the proper direction and a picture can be obtained by the topside adjustment of these controls.

Where Has Underwater TV Been Used Successfully?

As previously stated, the first real application of underwater television was at the atomic bomb test center at Bikini. Bombs caused ships to sink so quickly that inspection teams were unable to observe the damage in the conventional manner. By using television, the teams were able to see clearly the damage that had been inflicted.

In 1951, the English submarine Affray was sunk in the English Channel with all hands aboard. By the use of conventional acoustic sounding methods, many sunken ships were located but could not be identified. The television camera was used to inspect the various possibilities and positive identification was made by seeing the name of the ship on the conning tower. This system was operated for more than 300 hours and the contact was made in 280 ft of water. This application proved the practicability of the new industrial tool.

Another dramatic application of underwater television came in 1954 when the BOAC "Comet" exploded off the coast of Elba in 600 ft of water. Some of the pieces of the airplane were observed on the TV screen and examinations made that could not have been made by any other method.

There have been many other applications for underwater television that include: Ship salvage, underwater observation of missile firing, damage inspection on the underwater portion of ships, marine science observations, in fishery's research, offshore well drilling, etc.

The underwater television field is still comparatively young, but with its continued successful application, its use as an industrial tool should grow by leaps and bounds. ★ ★ ★

El Truex, *field engineer for the Arnold Barnes Company, holds a BS degree in mechanical engineering from Purdue University and a master's degree in business administration from Washington University in St. Louis, Missouri. He has held several engineering positions since his graduation from Purdue in 1953, including a two-year tour of duty as an Airborne Electronics Officer at Kelly Air Force Base, San Antonio, Texas.*

WmSON

SANDWICH

TAPPING VALVE

U. S. PAT. PENDING

A NEW MEMBER OF A WINNING TEAM!

Designed specifically for temporary use with WmSON Stopple Plugging Machines, Tapping Machines and Lock-O-Ring fittings, the Sandwich Tapping Valve completes the team of WmSON equipment used for tapping and plugging in order to repair or make additions to pipelines or piping without shutdown. Now, after extensive testing in both laboratory and field, the revolutionary Sandwich Tapping Valve is your answer to faster, easier, more economical tapping and stopple work. Faster and easier because it's smaller . . . lighter. Sandwich valves average ¼ as long (face to face) as standard valves . . . allow tapping and plugging in tight places where other equipment is difficult or impossible to use.

NEW! NEW! NEW!

And designed specifically for hot tapping

Plus these outstanding design features

- OVERSIZED BORE
- POSITIVE SHUTOFF
- BYPASS CONNECTION ON EACH VALVE
- INTEGRAL FLANGE STUDS

(Available in 600# series, sizes 4" and larger. Various sizes available for rental.)

For additional information write for Bulletin A-477

T. D. Williamson, Inc.

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METER MEASURES FLUID OF VARYING VISCOSITIES WITHOUT ADJUSTMENT

A METER THAT WILL measure fluid of varying viscosities without adjustment, and at flow rates up to 15,000 bbl per hr, was unveiled to the pipeline press this month by Rockwell Manufacturing Company.

The "press preview" was held at the company's Murrysville (Pennsylvania) test station. "Official" showings will be made during May at the International Petroleum Exposition in Tulsa, Oklahoma, and the American Petroleum Institute Transportation Section's Pipeline Conference in Pittsburgh.

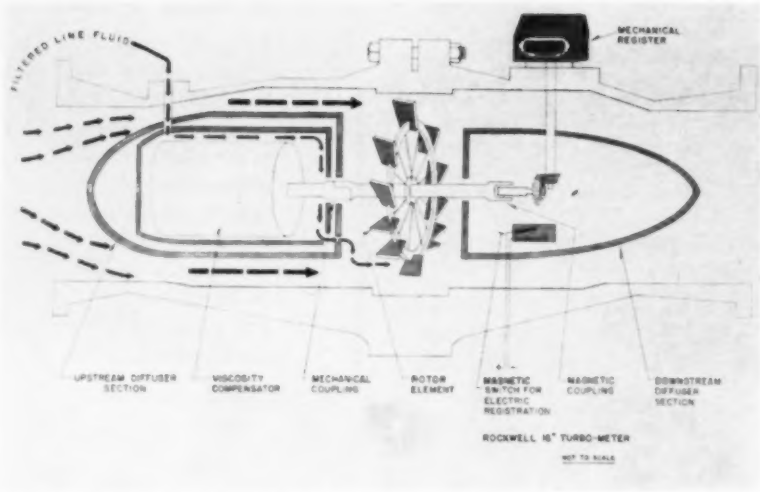
Termed the "Turbo-Meter", the model developed is a 16-in. instrument having these operational characteristics:

1. Capacity of 15,000 bbl per hr with liquids of up to 500 SSU capacity.
2. Accuracy of better than 15 parts in 10,000.
3. Repeatability of better than 1 part in 5000.
4. Low head loss.
5. Reduced cost.
6. Reduced weight — approximately 1000 lb.
7. Reduced calibration frequency.
8. Applicable to any liquid service, ranging from crudes to refined petroleum products without need for any adjustments to suit change in line liquid.

As the name implies, the Turbo-Meter is a turbine type meter. Unique features include a rotor metering element weighing only four pounds, a viscosity compensator, and a magnetic coupling that is completely sealed from the line product.

Design is based on the principle that there is a direct relationship between rate of liquid flow through the meter and the speed at which a rotor element is rotated by the force of the flowing liquid.

Metering element of this new instrument is the four-pound turbo-rotor. Rotor blades are low drag, air foil sections upon which the liquid flow impinges. On the upstream end of the rotor shaft is mounted a viscosity compensator. This is a new development that makes possible the metering of liquids of varying viscosities without the necessity of adjustment. The device provides a viscous brake type effect



Component parts of the Rockwell 16-in. Turbo-Meter.

to mechanically impose a drag on the turbo-rotor. The drag is directly proportioned to the viscosity of the liquid stream being measured. The result is to fix the amount of turbo-rotor slippage and maintain a constant relationship between flow velocity and rotor speed regardless of viscosity. Continuous viscosity correction is provided by feeding a small portion of the line flow through the viscosity compensator. The diverted liquid, however, is returned to the flow line upstream of the measuring element and is measured with the line flow.

Mounted on the downstream end of the turbo-rotor shaft is a two-pronged magnetic driver. It can be used to transmit power magnetically either to a mechanically actuated conventional register or to an electrically actuated register system. Regardless of the type of register used, the magnetic coupling transmission is a seated unit not exposed to the line product, and thus a conventional stuffingbox is not needed.

Torpedo-shaped diffuser sections guide the flow of the line fluid into and away from the turbo-rotor element. The upstream diffuser section houses the viscosity compensator. The downstream section houses the seated magnetic coupling register drive.

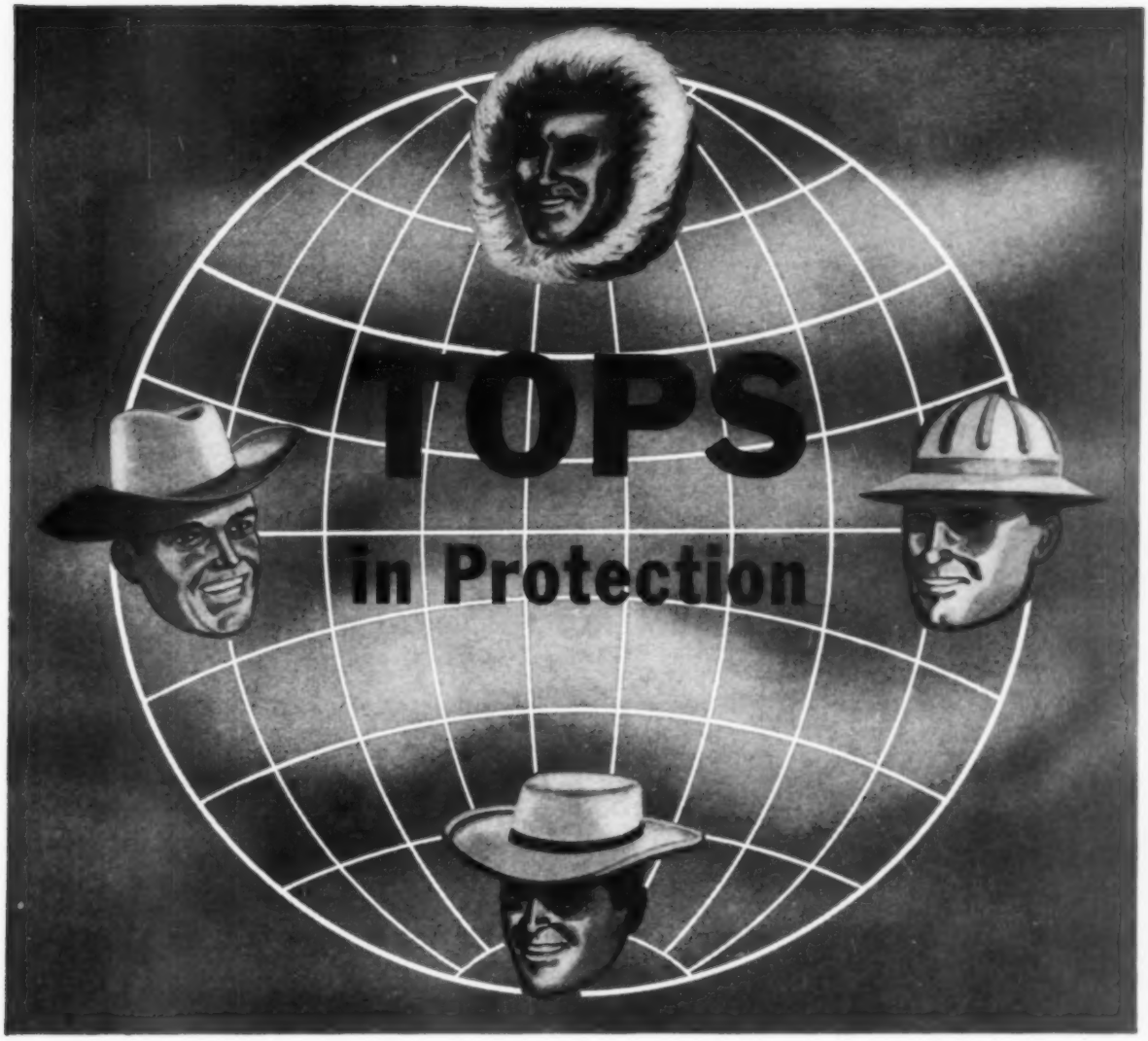
Diffusers are centered in the flow by means of four ribs on the inner surface of the meter housing, which looks simply like a flanged section of pipe and has an inside diameter no greater than the line pipe diameter.

How accurate is the new meter? At Rockwell's Murrysville test station facilities have been provided for making accuracy and repeatability tests involving up to 15,000 bbl per hr. These facilities consist of a 47,000 gal (over 1000-bbl) net capacity storage tank, a 47,000-gal capacity weigh tank, a 350,000-lb tank scale, and necessary 16-in. piping and equipment.

In running test demonstrations at the press showing, an oil having an API gravity of 30 deg and 310 SSU at 32 F was used. Kinematic viscosity at test temperature was 214 SSU at 43.7 F. Test quantities consisted of 700 bbl. Flow rates were over a range of 3734 to 13,394 bbl per hr.

To avoid possibility of reading error, simultaneous photographs were taken of scale and register readings at the beginning and end of a test run.

Tests consisted of two parts. First, points were obtained for the construction of an accuracy curve over the full range of flow. The sequence was then repeated to check repeatability. Registration was from 99.561 to 99.597 percent. ★ ★ ★



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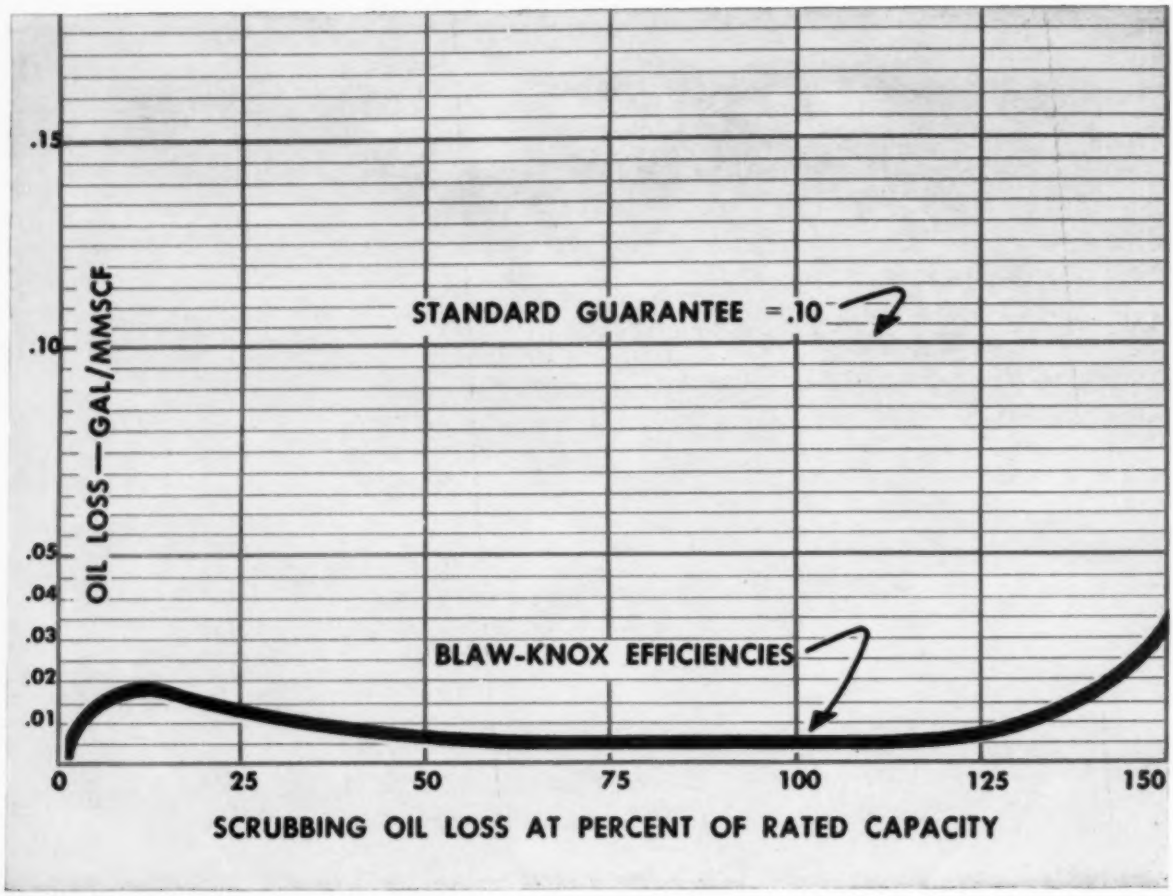

Now you can compare gas cleaner efficiencies with accuracy

Laboratory and field tests prove that the new Blaw-Knox Gas Cleaner has the best efficiencies at the widest range of gas flow. Three hundred individual tests plus six weeks of actual on-the-line field operation have been tabulated. The remarkable results are shown graphically in this illustration.

Through the entire range of the new Blaw-Knox Gas Cleaner the scrubbing oil loss at rated capacities is less than .02 gallons per million standard cubic feet of gas.

Accurate efficiencies of gas cleaners should be known before the decision to buy is made. Judge gas cleaners not only on how completely foreign particles are removed (Blaw-Knox can do this down to less than one micron), but also on how oil-free the downstream gas actually is.

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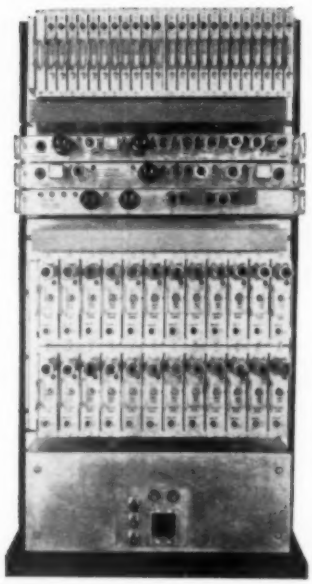
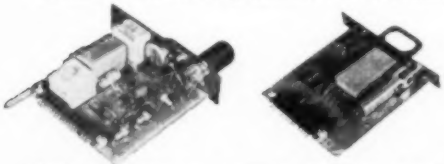
Kellogg Sets New Standards of Reliability in Microwave

Backed by the world-wide technical, manufacturing, installation and operating experience of ITT



New MICROPLEX provides 23 plug-in channel units in 3½ feet of space—a 4:1 size reduction



Each modulator and demodulator channel unit features printed circuitry.

Microwave was pioneered by ITT in 1931 with the Channel crossing from Calais to Dover. Today Kellogg Microwave is achieving new levels of reliability: 99.998%, far superior to wire line systems! Operating in dozens of installations throughout the world, Kellogg's *complete* communications package includes:

- *Microwave* — operating in the 2,000 and 10,000 megacycles bands.
- *Terminating Equipment*—for automating functions, including teletype, telemetering, remote control, data transmission.

Part of the Kellogg 10-C Microwave System is the new 10-C-2 "Microplex": a 23 or 45 channel PTM multiplexing equipment. It features printed circuits, miniaturized components, minimum maintenance, and occupies only three-and-one-half feet of rack space. All demodulators are semi-passive—only one tube per channel; modulators are passive—no tubes. The 23 channels use 41 tubes with an input of 180 watts —a 5:1 reduction in power consumption.

MICROPLEX may also be packaged in one seven-foot rack to provide 45 channels; or 23 channels with two-wire termination and tone signaling. Signal crosstalk is 62 db and signal-to-noise (F1A) is 70 db for 23 channels.

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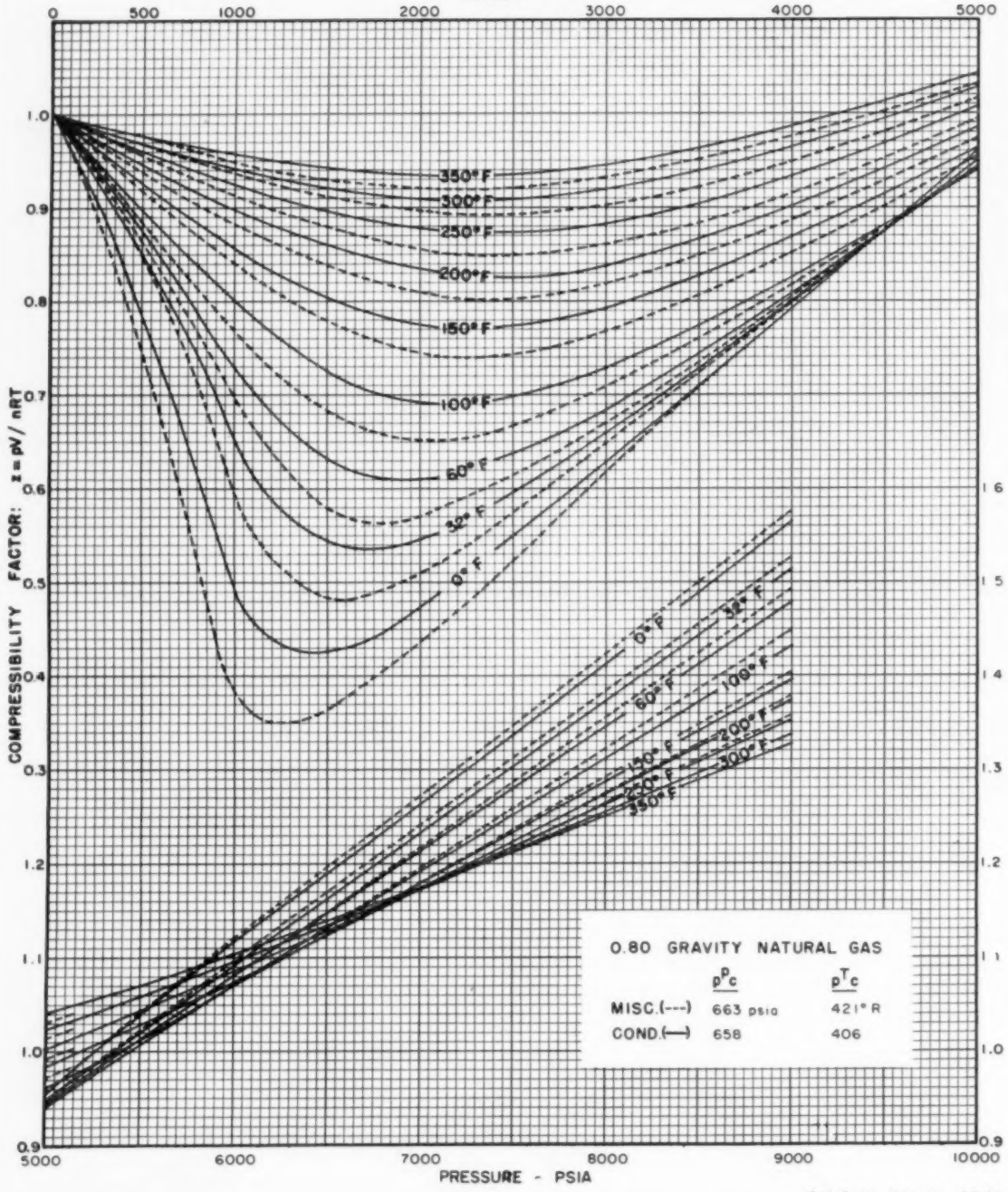
SIMPLIFIED COMPRESSIBILITY FACTOR CHARTS FOR NATURAL GAS CALCULATIONS

CHART 4



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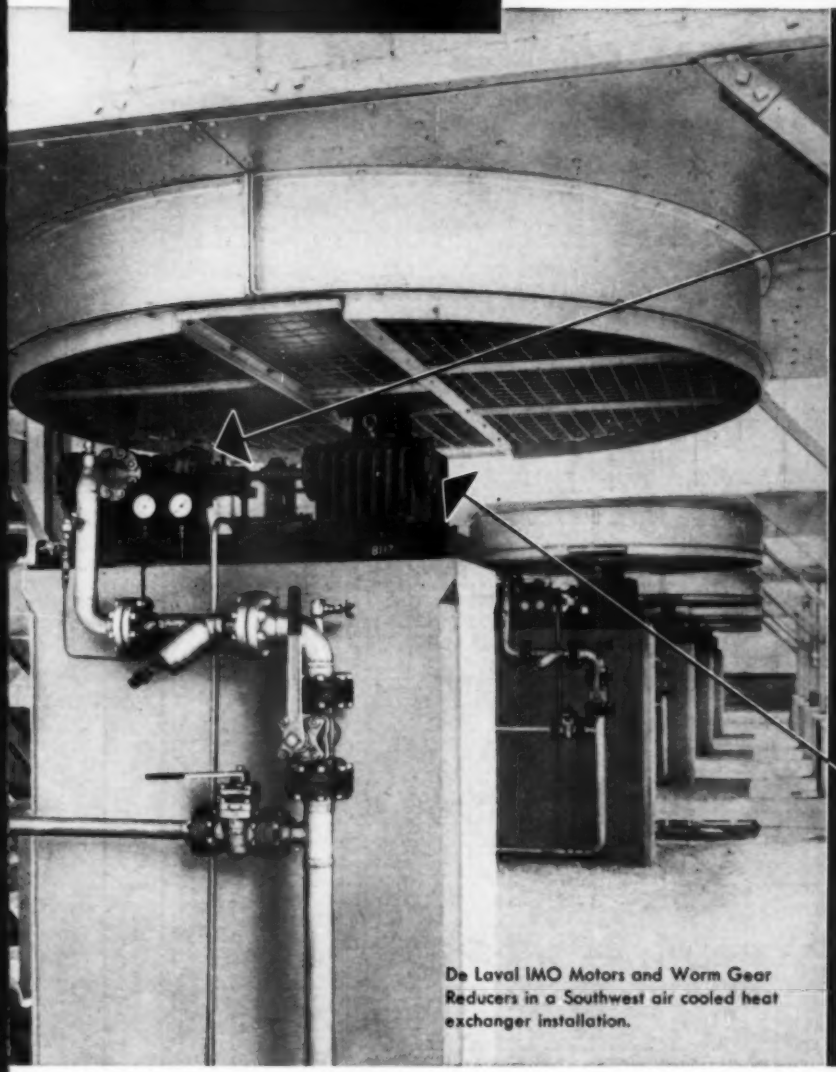
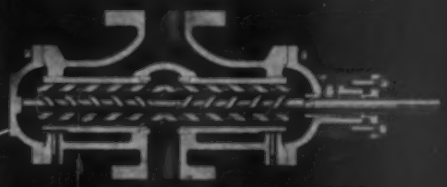


De Laval IMO Motors and Pumps



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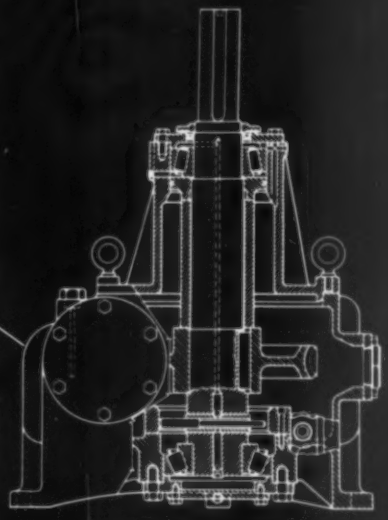
De Laval Worm Gear Speed Reducers



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De Laval IMO Motors and Worm Gear Reducers in a Southwest air cooled heat exchanger installation.

De Laval Hydraulic Fan Drives for air cooled heat exchangers and cooling towers *save power* since the fan operates at full speed only a portion of the time. Furthermore, there is no demand charge on hydraulic power. • Equally important, they provide *accurate*, *automatic* control of engine jacket water temperature, and also assure *complete operational flexibility*. Due to the simplicity of De Laval IMO motors and pumps as well as the rugged construction of De Laval Worm Gear Reducers, these units stay on the job for years. Both IMO motor and speed reducer are mounted and factory aligned on a single bedplate.

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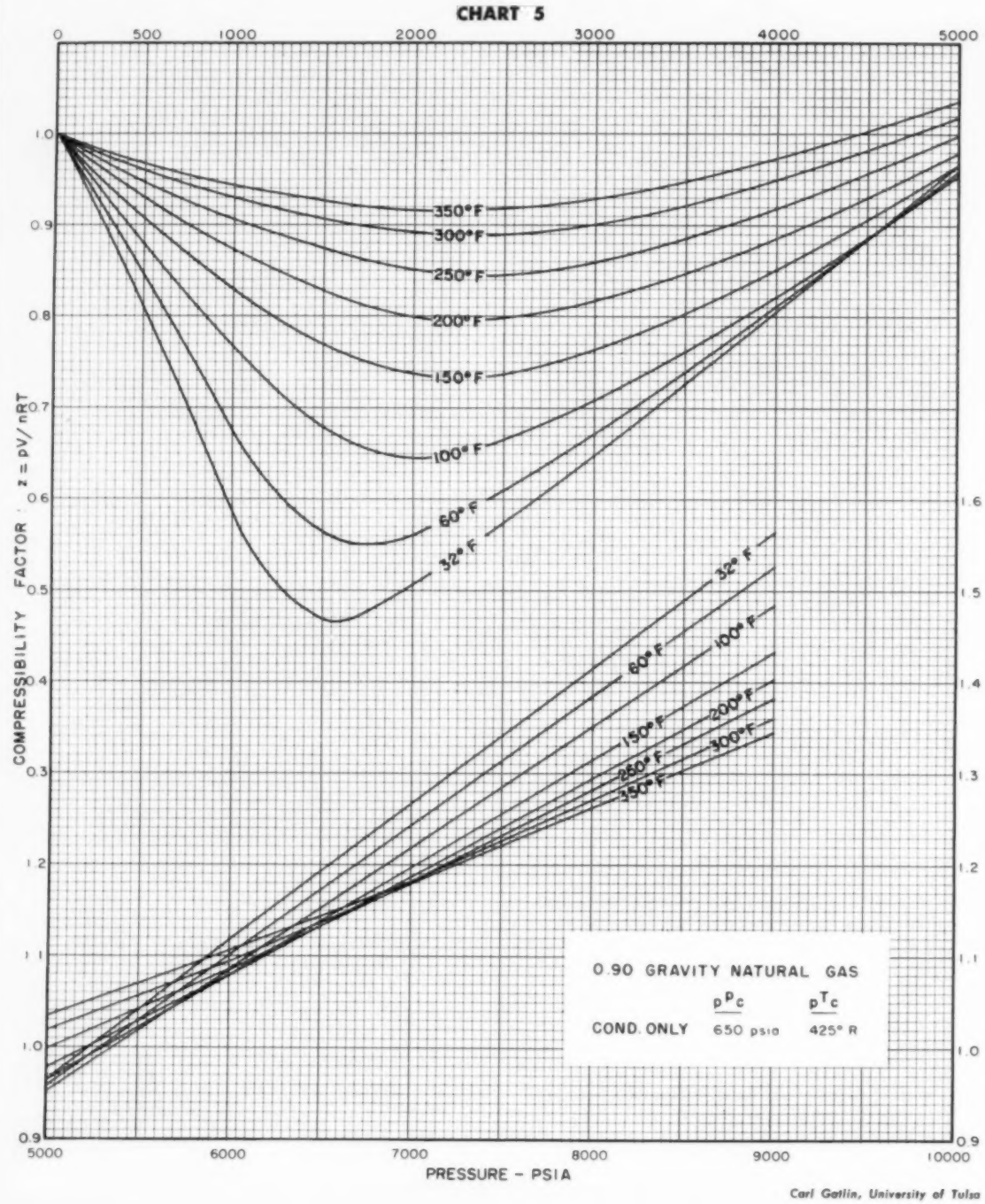
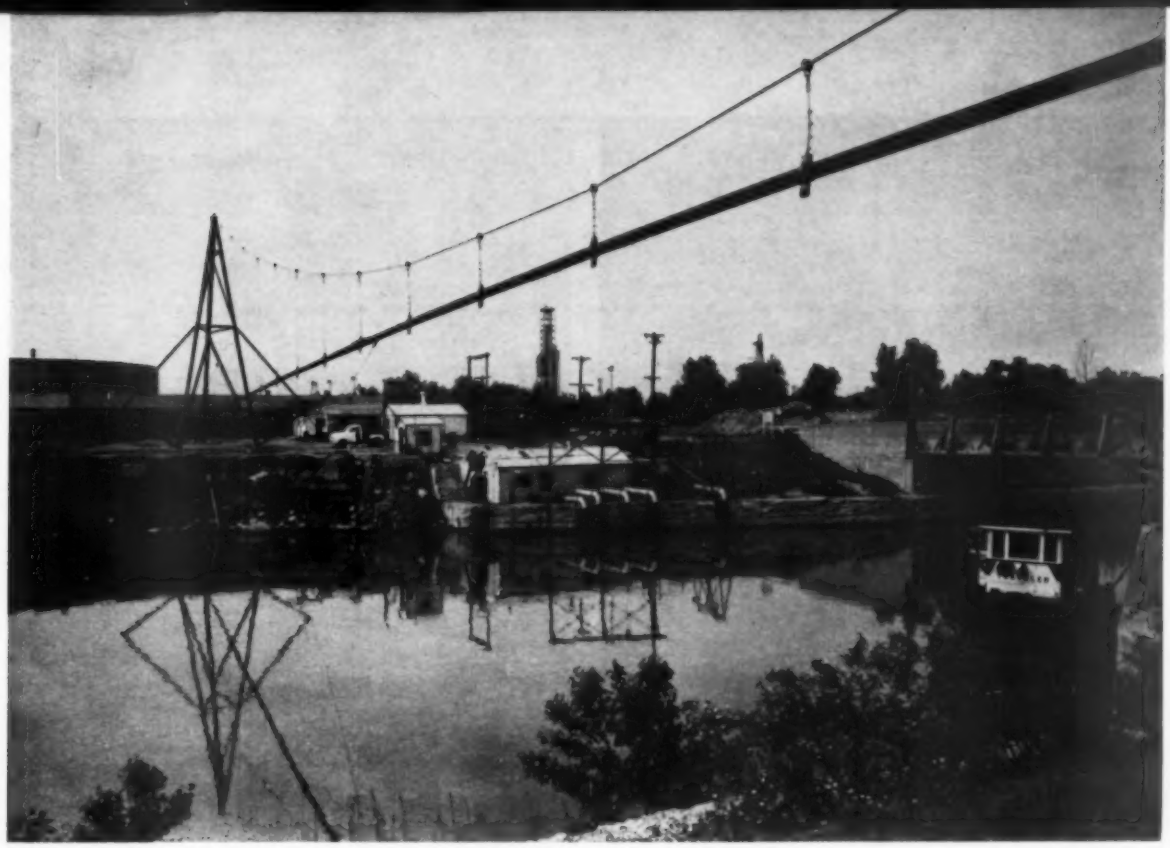
SIMPLIFIED COMPRESSIBILITY FACTOR CHARTS FOR NATURAL GAS CALCULATIONS



Carl Gatlin, University of Tulsa



Blue Island aerial span completed across the Calumet Sag Canal just outside Chicago.

P 615.371.

AERIAL SPANS CUT RIVER CROSSING COSTS

Two recently constructed bridges of new type said to save 20 to 40 percent compared with cost of underwater crossings

THE TWO AERIAL pipeline spans described in this article, and pictured in various stages of erection, represent at least one reversal in the inflationary spiral of pipeline construction costs. In each instance, the final bill tallied up between 60 and 80 percent of the cost of a conventional underwater crossing at the same site.

One of the spans carries Clark Oil and Refining Company's 8-in. products line across the busy Calumet Sag Canal at Blue Island, Illinois, just outside Chicago. The second line lifts Houston Natural Gas Corporation's 18-in. gas line above the treacherous (for pipelines) Trinity River near Liberty, Texas.

The two bridges are the 14 and 15th of this type to be designed by and constructed under the supervision of Clear Span Engineering Company, Inc., Houston, Texas.

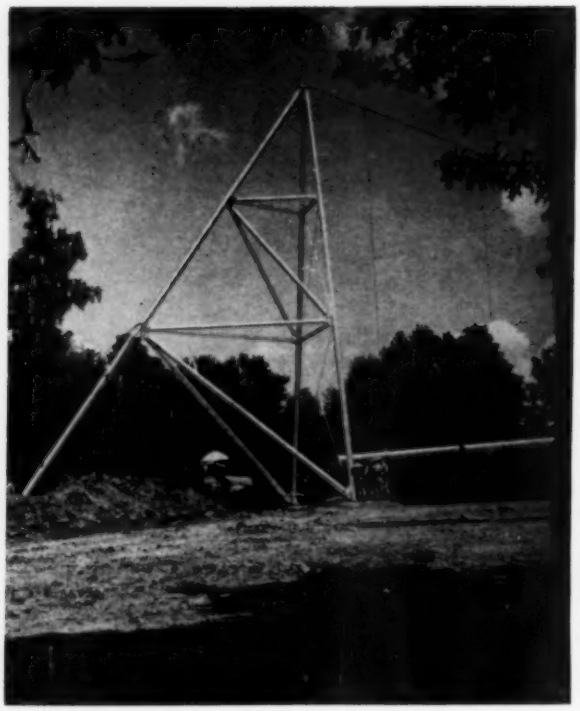
Houston Natural's 540-ft, 18-in. gas line is the largest diameter line to be supported by this type bridge so far, but it is by no means the longest span. Yellowstone Pipe Line Company installed seven similar bridges in Montana early in 1954 — one of them measured 1220 ft between towers.

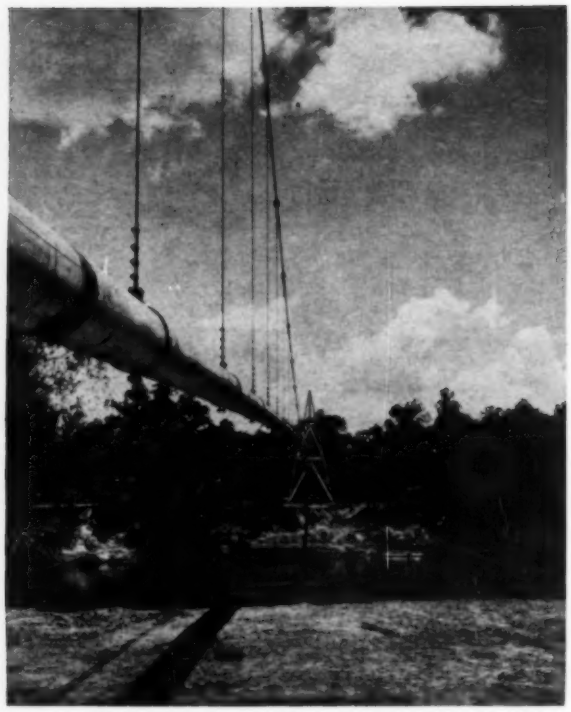
Enhancing pipeliners' interest in bridges of this type today is the successful history of Yellowstone's crossings. In the recent severe winters, the bridges have withstood heavy icing and high velocity winds with no apparent trouble.

Simplicity of Design

From the design standpoint, this aerial suspension bridge is simplicity itself. There are few indeterminents, and any competent structural engineer can easily analyze stresses in the various members. Basically, an overhead wire strand, suspended between two tripod towers, supports the pipeline through light suspenders hanging vertically. The two front legs of the tower, which face the stream, carry the weight of the wire strand and pipe; the back leg away from the river, is welded to a heavy anchor block whose weight counterbalances the former.

Lateral movement of the pipe is restricted by wind cables attached at sev-





Trinity River aerial span that supports 540-ft, 18-in. line across a river that has proved troublesome for pipelines.

eral points on the pipe and running to anchor blocks onshore or to wind trusses on the towers.

Design factors. The spans are designed to withstand extreme ice and wind loads — the latter being designed for 125 mph winds blowing in gusts, the usual upper limit of Gulf Coast hurricanes. All bridges are designed against vibration and pulsation, and none has thus far shown any trouble in this respect.

Ease of erection. The bridge is completely prefabricated (except for the line pipe) shipped to the jobsite, assembled on shore, floated or trollied across the stream, and hoisted up into place. The latter operation usually can be accomplished in a matter of minutes.

Procedure. Here is the usual procedure followed in erecting one of these bridges. Foundations for the tripods (and for wind anchor blocks, where used) are started first because the concrete curing is the limiting factor on the speed of construction. The towers, which have been pre-assembled, tested, and color coded for construction at the fabricating shop, are welded up on the job with the two front legs lying on the ground and the apex of the tower spotted toward the river. Prior to erection, the front legs are pinned to the proper foundations so the tower can pivot upright.

The wire rope, pre-cut at the factory is strung out alongside the aerial pipeline section, and the small suspenders (usually of ½-in. galvanized bridge rope) are clamped to the pipe at carefully measured intervals and to the main suspender strand or strands. The erectors tie the wire rope to the pipe with light manila line, and the assembly is snaked across the stream.

Final erection takes only a few minutes. The two ends of the main strands are pinned to the tops of the two towers, and first one, then the other, is winched upright by a tractor or winch truck. When the second tower reaches upright position, the pipeline assumes its final camber. Final erection tasks are to weld the back legs to the foundations, make the pipeline tie-ins, and tighten the wind cables.

Calumet Sag Canal Crossing

Summed up, Clark Oil & Refining Company's problem was this—How to lay a pipeline across a 200-ft canal that would shortly be widened to 400 ft? Laid underwater, the high rocky banks would have to be blasted and dredged beyond and below the future limits of the canal. The cost of the dredging and blasting would have approximately equalled the cost of the completed aerial span, so the decision was easily reached. Besides, blasting and dredging in a busy waterway would have been somewhat hazardous.

Clear Span Engineering Company designed a 431-ft aerial suspension bridge that would support two lines — initially an 8-in. with a 12-in. line to be

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Quoted from Mr. Dillard Stokes' Column, Shreveport Journal, Oct. 13, 1958.
"President Washington, who spoke of usurpation, said in his Farewell Address: 'If in the opinion of the people, the distribution of the Constitutional powers be in any particular wrong, let it be corrected by an amendment . . . but let there be no change by usurpation; for . . . this is the customary weapon by which free governments are destroyed'."
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added later — high above the water traffic. Because of the methods used in constructing the line, normal traffic would be interrupted about an hour.

The tripod towers on Clark's aerial suspension span are 63-ft high. The two front legs are constructed of 12-in. diam, 0.375-in. wall pipe — the back legs are 16-in. diam, 0.312-in. wall pipe. After they were assembled, tested, and color coded at the fabricator's shop, they were cut apart and shipped to the jobsite where Midwestern Contractors, Inc., of Wheaton, Illinois, reassembled them under the direction of Clear Span engineers. At the same time, foundations were excavated and poured.

Meanwhile, Bethlehem Steel Corporation had cut a piece of 1⅞-in. galvanized bridge strand wire rope to proper length and carefully marked the location of clamps for the suspender cables. This main strand was prestressed to 60 percent of its capacity. After the pipeline had been welded up, this suspension strand was strung alongside it and clamped to the 8-in. pipeline by means of ½-in. suspender ropes. Wind cables also were clamped.

The wire rope was bundled to the pipeline and the assembly was snaked across the Calumet Sag on a temporary wire rope trolley.

Once across, the main suspender was pinned to the tops of the two towers and the actual erection began. First one tower, then the other, was pulled upright by a winch truck pulling through two 2-sheave blocks, one attached to a special pad eye in the foundation, the other to the back tower leg.

As each tower reached upright position, the 16-in. back leg was welded to another 16-in. pipe that extended to the bottom of the foundation.

Wind cables were attached to trusses on the tower and tightened with turnbuckles. The force is counteracted by tie cables extending to the foundation of the back leg.

To add the second line, Clark can cut the back legs of the two towers, lowering them with block and tackle in the same manner used in erection. The 12-in. line can then simply be floated into place on the water and clamped to the 8-in. line. The towers will then be hoisted upright and the back legs re-welded. Another method would be to snake the line on trolleys beneath the existing 8-in. line, and hoist into a tandom position without taking the 8-in. line out of service.

Trinity River Crossing

Structurally, the requirements for a bridge to support Houston Natural's 540-ft long, 18-in. gas line were less than those of the bridge to support Clark's two products lines. The primary difficulty was the low bearing capacity of the river's banks.

Towers are 66-ft high with front legs of 10-in. pipe and back legs of 14-in. The main suspension strand is 1¾-in. galvanized bridge strand, prestressed to 60 percent of capacity. The suspenders are of ½-in. galvanized bridge rope.

Five piles were driven beneath each of the foundations for the front legs, which measured 8-ft 6-in. square and 4 ft deep. Three piles were driven beneath each of the back leg foundations to provide lateral stability. As mentioned, the primary purpose of the latter is to counterbalance the weight of the pipeline. With the back leg in tension, the primary load on this foundation is negative. In this instance, the foundations for the back legs were far larger than those of the front legs. They measured 14-ft 6-in. square and 9-ft 6-in. deep giving a total volume of about 74 cu yd of concrete.

Wind anchors of 9 cu yd each were poured 50-ft on either side of the centerline of the pipe. Two wind cables, one ¾-in., the other ⅝-in., run from each anchor out to the pipeline suspended over the water.

The work on the Houston Natural Gas line was done by Troy Construction Company of Houston. ★ ★ ★

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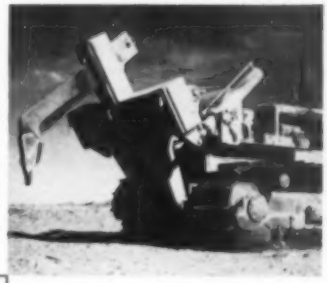

CONDENSED SPECIFICATIONS

ITEM	D-9	D-8	D-7
Weight Complete—Approx.	15,600 lbs.	12,500 lbs.	10,800 lbs.
Shank Sizes*—With Boot	3½" x 12" x 97" 3½" x 14" x 97" 3½" x 14" x 104"	3½" x 12" x 97"	2½" x 12" x 84"
Shanks Furnished	1	1	1
Boots Furnished	1	1	1
Width	118"	95½"	92"
Length	124"	107"	107"
Length—(Back of Tractor to Pivot Point of Shank)	114"	92"	92"
Maximum Depth	84"	72"	60"
Maximum Out of Ground	18"	18"	12"
Hydraulic Pump Capacity	1,000# Pressure 77 GPM @ 1200 RPM	1,000# Pressure 50 GPM @ 1200 RPM	1,000# Pressure 50 GPM @ 1200 RPM
Hydraulic Cylinders 2¾" Ram Dia.	7" Dia. 48" Stroke	6" Dia. 48" Stroke	5" Dia. 42" Stroke

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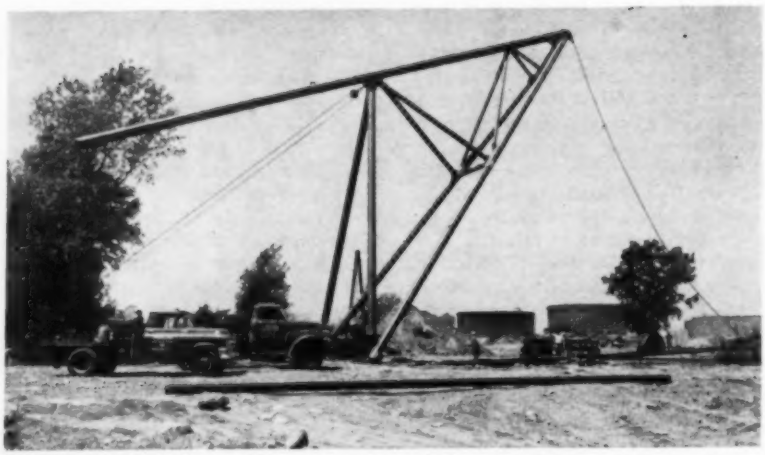
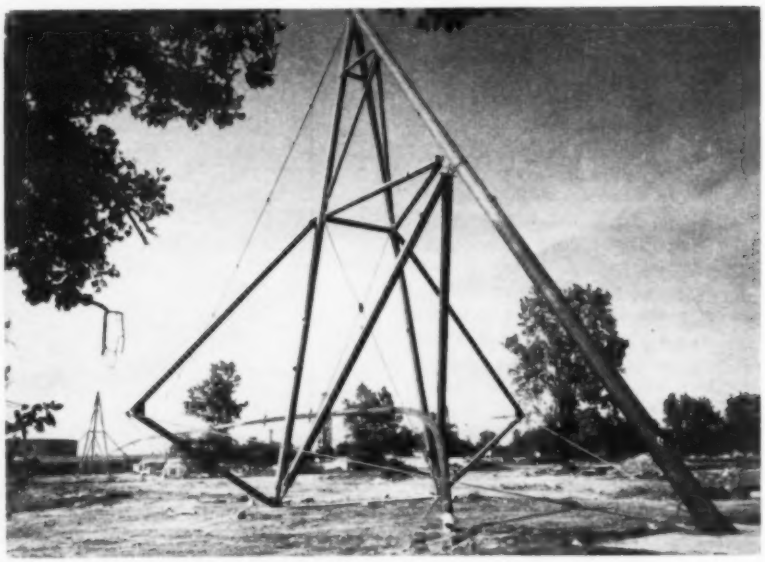


Blue Island tower goes erect. Winch truck supplied necessary power.



Wind trusses complete the Blue Island bridge.

Trinity River crossing on its way up. Note the wind cables in the foreground. All parts of the bridge except the pipeline itself are prefabricated.

Pipeline Projects

FPC Accepts For Filing $91,179,196 Project

Colorado Interstate Gas Company's proposed $91,179,196 natural gas pipeline project, extending from Texas to Oklahoma, Kansas, Colorado, Wyoming, and Utah, has been accepted for filing, the Federal Power Commission announces.

The proposal includes the construction of approximately 359 miles of 20 to 34-in. transmission line from the West Panhandle field of Texas to Denver, Colorado, 85.7 miles of various diameter pipeline to tie in new reserves in Kansas, Oklahoma, and Wyoming, 155 miles of 34-in. line between Green River and Provo, Utah, 32 miles of 6-in. line in Colorado to continue service to the city of Trinidad, Colorado, and reversing the flow in its existing line between Denver and Green River, Wyoming.

Colorado Interstate's proposal also includes building nine compressor stations with a total capacity of 45,980 hp, adding a total of 24,600 hp to four existing stations, and retiring about 275 miles of its Bivins, Texas, to Denver transmission line and seven compressor stations having a combined capacity of 27,115 hp.

In the proposal would be the sale of 239,010,000 cu ft of natural gas daily to El Paso Natural Gas Company at a point near Green River, and the transportation for El Paso of up to 478,020,000 cu ft of gas daily from Green River to Provo. The additional gas would be purchased by El Paso from Pacific Northwest Pipeline Corporation at Green River.

The facilities would also increase the daily delivery capacity of Colorado Interstate's existing pipeline system in the Rocky Mountain area by approximately 49,000,000 cu ft to meet future firm peak requirements of existing customers.

Iron Range Proposes Minnesota Lines

An application filed with the Federal Power Commission by Iron Ranges Natural Gas Company proposes construction and operation of a natural gas pipeline system comprising two main pipelines.

One of these, the Mesabi line, the estimated cost of which is set at $3,500,000, would extend approximately 79 miles along the Mesabi range from Grand Rapids to Hoyt Lakes, Minnesota. The second line proposed, the North Shore line, would extend approximately 67 miles from Duluth, along the North Shore of Lake Superior, to Silver Bay, Minnesota, and would cost an estimated $2,350,000.

The capacity of the Mesabi line would be 58,000,000 cu ft per day, while the capacity of the North Shore line would be 25,000,000 cu ft per day.

Transco's Offshore Plan Gets Examiner's Approval

Transcontinental Gas Pipe Line Corporation's proposal to construct three purchase laterals and meter stations to enable it to receive natural gas from offshore Louisiana has been authorized in a decision handed down by a Federal Power Commission presiding examiner, subject to review by the commission. The facilities, estimated to cost about $2,135,000, will include a 13-mile, 16-in. lateral; a 1.83-mile, 16-in. lateral, and a .71-mile, 12-in. lateral.

Presiding Examiner Harry W. Frazee also authorized Superior Oil Company to sell natural gas to Transco from the Block 71 and Block 76 fields, offshore Vermilion Parish, and denied requests by the United Gas Improvement Company of Philadelphia, Pennsylvania, and the Public Service Commission of New York to condition the initial price of the gas at 17 cents per Mcf. Superior proposed an initial price of 21.4 cents per Mcf.

The total estimated reserves to be acquired from Superior approximate 1 trillion cu ft. Transco has already acquired, with FPC authorization, over two-thirds of the gas in the Block 71 and Block 76 fields at an initial price of 21.4 cents per Mcf. Transco, through this agreement with Superior, will acquire the remainder of the production from the two offshore fields.

Oklahoma Gas Line Underway

Northern Oklahoma Gas Company is building a $2,500,000, 75-mile long, 12-in. natural gas pipeline from Ponca City to near Cherokee, Oklahoma. O. R. Burden Construction Company of Tulsa has been awarded the construction contract for the line which will reach newly discovered gas fields in Alfalfa and Grant counties.

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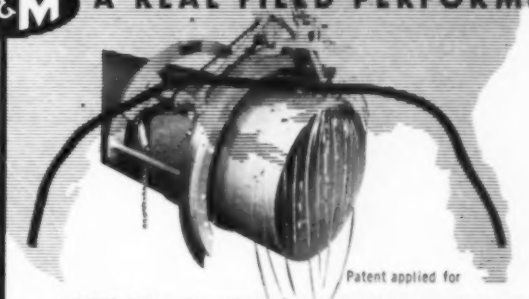

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N. Y. State Natural Line Approved, '59 Plans Told

New York State Natural Gas Company has been authorized by the Federal Power Commission to build approximately 27 miles of 20-in. transmission line from Elk County to Clearfield County, Pennsylvania, at a cost of about $1,538,000, the facilities to be used to take gas produced in the Luthersburg field, Clearfield County, Pennsylvania.

The FPC had previously granted temporary authorization for the proposal.

In addition, New York State Natural announces plans for 1959 additions and improvements to cost nearly $14,000,000. Major projects planned include: Construction of 43 miles of 20-in. pipeline from a point west of Kittanning to Luthersburg, Pennsylvania; construction of 14.5 miles of 26-in. pipeline from Little Marsh in Chatham Township to the company's Boom compressor station near Lawrenceville, Pennsylvania; addition of gas compressor engines to stations at Woodhull and Utica in New York, and Preston and Tonkin in Pennsylvania; further development work in the company's Woodhull storage pool, Steuben County, New York, to increase the underground reservoir's capacity to 35.2 billion cu ft of gas; and participation in the construction of the Leidy storage pool, Clinton County, Pennsylvania, which, when ultimately completed, will have a storage capacity of approximately 105 billion cu ft of gas.

Jayhawk-Oklahoma Field Link

Cameron Crude Oil Corporation of Tulsa, Oklahoma, has announced plans to construct an 8-in., 30-mile crude oil and condensate pipeline that would link the Southeast Stockholm field and the North Buffalo field, in Harper County, Oklahoma, with Jayhawk Pipe Line Company's Kansas line at the Harper Ranch station. The line would cost approximately $1,500,000.

Pemex Pipeline Financed

Mexico is reported to have concluded negotiations for a $40,000,000 credit from four New York banks to finance construction of a natural gas pipeline linking the producing areas around Tabasco in southeast Mexico and the gas consuming region of Mexico City. The credit will be extended to Mexico's Nacional Financiera and Pemex, Mexico's national oil company, and will provide foreign exchange for Pemex to construct the line.

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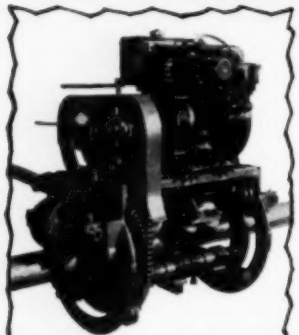

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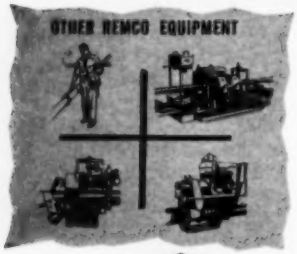

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HP Increase By El Paso Given Temporary Okay

El Paso Natural Gas Company has received temporary authority from the Federal Power Commission to add 2200 hp to its Eunice field compressor station, bringing the capacity of this station to 22,100 hp, and to install additional metering facilities. The facilities, at an estimated cost of $867,000, will enable El Paso to purchase approximately 17,420,000 cu ft of residue gas daily from Phillips Petroleum Company, also granted temporary authority to sell the gas to El Paso.

The gas is to be produced from the South Eunice, Langlie Mattix, Jalmat, and San Simon fields in Lea County, New Mexico.

Short Gas Pipeline Okayed

Columbia Gulf Transmission Company has received authorization from the Federal Power Commission to construct 11 miles of 12-in. lateral supply line and appurtenant facilities to extend southwesterly from its existing pipeline to a point in the Block 17 field, East Cameron area, Cameron Parish, Louisiana, at a cost of approximately $820,000. The FPC had previously granted temporary authorization for this proposal.

The FPC also authorized Shell Oil Company to sell gas produced in the Block 17 field to Columbia's affiliate, United Fuel Gas Company. Columbia will use the proposed facilities to transport and deliver the natural gas to United at Means and Leach, Kentucky.

Argentine Pipeline Expansion

The Argentine State Gas Agency (Gas del Estado) plans to expand the Comodoro Rivadavia-Buenos Aires gas pipeline system with construction of: A branch line from the main line at Bahia Blanca to Mar del Plata; a new mainline section between Bahia Blanca and Olavarria to convert the latter's cement industry from fuel oil to natural gas; a new mainline section from Plaza Huinculf fields, Neuquen Province, to Bahia Blanca; a new mainline section between Canadon Seco and Puerto Madryn; a new mainline section between Puerto Madryn and Rio Colorado; and a new line from Comodoro Rivadavia south to Puerto Deseado. Plans for the latter two are to be held in suspense pending consumption studies.

Scheduled to be in service by May on the existing line are two new gas compressors that will boost the line's carrying capacity by 5,808,900 cu ft a day, an increase of about 13 percent over the present capacity.

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WITH THE PIPELINE CONTRACTORS

● **B & M Construction Corporation, 2808 First National Bank Building, Oklahoma City, Oklahoma.** Has been awarded a contract to build 218 miles of 8-in. line for *National Iranian Oil Company* from Tehran to Resnt, Iran.

● **Brown & Root, Inc., 4100 Clinton Drive, Houston, Texas.** Has contract with *Texas Eastern Transmission Corporation* to furnish field supervision for construction of 626 miles of 30-in. loops along the company's line between Beaumont, Texas, and Uniontown, Pennsylvania.

● **O. R. Burden Construction Corporation, P. O. Box 5216, Tulsa, Oklahoma.** Constructing gathering system in Jack and Wise counties, Texas, for *Natural Gas Pipeline Company of America* to connect 84 new wells. Also has been awarded a contract by *Northern Oklahoma Gas Company* to install 70 miles of 10 and 12-in. line between Cherokee and Ponca City, Oklahoma; and has been awarded a contract to construct 62 miles of 8-in. petroleum products pipeline connecting the *Texas Eastern Transmission Corporation* refinery at Tyler to the Little Big Inch pipeline system at Carthage.

● **Collins Submarine Pipelines, Ltd., London, England. (Collins Construction Company, P. O. Box 86, Port Lavaca, Texas.)** Has been awarded a contract by the *British Atomic Energy Authority* to install 12,000 ft of 6-in. pipeline at the shore at Winfritheath, England, (near Lulworth), to a depth of 80 ft, in the English Channel.

● **H. L. Gentry Construction Company, 921 East Michigan, Jackson, Michigan.** Has been awarded a contract by *North Carolina Natural Gas Corporation* to construct in excess of 163 miles of pipe ranging in size from 6 in. to 12 in.

● **Groninger & King, Inc., P. O. Box 1381, Pampa, Texas.** Has contract to install 7 miles of 4 and 6-in. addition to the gathering system of *Caltexo Corporation.*

● **B. C. Hall Constructors, Inc., P. O. Box 644, Aztec, New Mexico.** Has contract to build an undetermined amount of various sizes of pipelines ranging from 4-in. through 20-in. for *El Paso Natural Gas Company* in the Four Corners area of New Mexico.

● **Hallmac Construction Company, 3701 Buffalo Drive, Houston, Texas.** Has been awarded a contract by *United Gas Pipe Line Company* to install 43 miles of 30-in. pipeline from Mandeville, Louisiana, to Kiln, Mississippi.

● **Harbert Construction Corporation, P. O. Box 1369, Birmingham, Alabama.** Has nearly 500 miles of 18-in. and 20-in. main gas lines and more than 600 miles of 4-in. through 16-in. lateral lines under contract with *Houston Texas Gas and Oil Corporation* from Bradenton, Florida, to Miami, Florida.

● **Hunsaker Trucking Contractor, Inc., P. O. Box 97, Carrollton, Texas.** Has contract to string 104 miles of 24-in. pipeline from Sulphur, Louisiana, to Smith Point, Texas, for *Coastal Transmission Corporation.*

● **International Marine Constructors, C. A., Caracas, Venezuela. (Collins Construction Company, P. O. Box 86, Port Lavaca, Texas.)** Has been awarded a contract by the Iranian Oil Company to lay 25 miles of 30-in. at Ganaweh, on the Iranian shore, to Kharg Island, approximately 25 miles out in the Persian Gulf.

● **Macco Corporation, 14409 South Paramount Boulevard, Paramount, California.** Has prime contracts with various companies to construct pipelines in various sizes through 30-in. in California.

● **Majestic Contractors, Ltd., 408 Royal Trust Building, Edmonton, Alberta, Canada.** Has an undetermined amount of gas gathering system for *Producers Pipeline Company* in the Estevan, Saskatchewan, area.

● **McVean and Barlow, Inc., P. O. Box 151, Odessa, Texas.** Has a contract to build 116 miles of 20-in. pipeline for *El Paso Natural Gas Company* in West Texas and Eastern New Mexico.

● **Mid-States Construction Company, P. O. Box 417, Mt. Vernon, Illinois.** Has been awarded contract to build 5.5 miles of 4-in. from Gainesville junction to Gainesville, Florida; 46.5 miles of 16-in. from the Brooker main line junction to Jacksonville, Florida; and 7 miles of 3½-in. from the Stark junction to Stark, Florida, by Harbert Construction Corporation, prime contractor for *Houston Texas Gas and Oil Corporation.*

● **Midwestern-Waleo Contractors, P. O. Box 11507, 1431 4th Street South, St. Petersburg 33, Florida.** Has been awarded a contract by *Houston Texas Gas & Oil Corporation* to lay approximately 700 miles of 24-in. main line between Baton Rouge, Louisiana, and Kissimmee, Florida, including a 24-in. crossing of the Choctawhatchee River at Caryville, Florida, and an 18-in. crossing of the Mobile River at Mt. Vernon, Alabama, and three compressor stations at Wiggins, Mississippi; Munson, Florida; and Quincy, Florida.

● **J. P. Neill & Company, Inc., 1200 Exchange Bank Building, Dallas 35, Texas.** Has been awarded 112 miles of 16-in. pipeline by *North Carolina Natural Gas Corporation* from Iredell County to a point northwest of Lumberton, North Carolina.

● **Oklahoma Contracting Company, P. O. Box 13227, Dallas 20, Texas.** Has contract for 130 miles of 24-in. between Lake Charles, Louisiana, and Baton Rouge, and 150 miles of 20-in. from Driscoll to Bay City, Texas, for *Coastal Transmission Corporation.*

● **Panama, Inc., 2201 Commerce Building, Houston 2, Texas.** Has been awarded a contract by *Humble Oil & Refining Company* to construct 238 miles of 30-in. natural gas pipeline from the King Ranch in Texas to the Clear Lake gas plant in Houston, Texas.

● **River Construction Corporation, P. O. Box 9127, Fort Worth 7, Texas.** Has contract to lay 104 miles of 24-in. line for *Coastal Transmission Corporation* from Sulphur, Louisiana, to Galveston, Texas.

● **Sharman, Allen, Gay & Taylor, Inc., 3115 Buffalo Drive, Houston, Texas.** Has a contract to build 63 miles of 22-in. pipeline between Bay City and Galveston, Texas, for *Coastal Transmission Corporation.*

● **Sheehan Pipe Line Construction Company, 514 National Bank of Tulsa Building, Tulsa, Oklahoma.** Has been awarded a contract to construct for *Buckeye Pipe Line Company* 11 miles of 6-in. pipeline from Verona, New York, to Rome, New York.

● **Vaughn & Taylor Construction Company, Inc., P. O. Box 3266, Odessa, Texas.** Has contract for waterflood system at Kamay, Texas, consisting of 55 miles of 2-in. to 12-in. line for *Shell Oil Company.*

● **Williams Brothers Company, National Bank of Tulsa Bldg., Tulsa, Oklahoma.** Has contract to build segments of a *Natural Gas Pipeline Company of America* line, consisting of 185 miles of 36-in. in Nebraska and Kansas, and 98 miles of 34-in. in Iowa.

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Pipeline Personals

Charles R. Younts, president of Plantation Pipe Line Company, has been elected chairman of the board of the corporation, and **Malcolm E. Grant,** executive vice

C. R. Younts

M. E. Grant

president, has been elected president and chief executive officer. Younts assisted in the original organization and construction of Plantation's system and was named as the company's first president in 1941. The company's new president, Grant, has been executive vice president since 1952.

William B. Poor has been elected senior vice president of Ford, Bacon & Davis, Inc. As vice president and manager of the construction department, Poor, who joined the company in 1948, has had direct charge of work for the natural gas industry and general supervision of all construction. He is also a member of the executive committee of the firm, as well as vice president and director of two of its wholly-owned subsidiaries, Ford, Bacon & Davis Construction Corporation and Ford, Bacon & Davis Canada, Ltd. **Charles C. Whittelsey,** president, also announced the appointments of **Russell P. Westerhoff** as chief engineer and of **Stuart R. Fleming** as manager of the engineering department of Ford, Bacon & Davis, Inc.

V. W. Meythaler has been elected vice president and treasurer of Texas Gas Transmission Corporation by its board of directors, **W. M. Elmer,** president of Texas Gas, has announced. Meythaler was formerly treasurer of the company, and in his new position will retain the responsibility for that function.

W. C. McGee, Jr., president of Tennessee Gas Pipeline Company, an operating division of Tennessee Gas Transmission Company, has announced the division's officers and the responsibilities of each. They are: **L. W. A. Campbell,** vice president, in charge of engineering; **T. K. Davis,** vice president, responsible for compressor, gas control and measurement operations; **J. L. Parrish,** vice president, in charge of pipeline construction, research, radio and corrosion prevention; **O. H. Simonds, Jr.,** vice president, supervising sales and planning; and **B. J. Whitley,** vice president, in charge of pipeline operation, maintenance and right-of-way matters.

Richard W. Warren has been elected vice president of Buckeye Tank Terminals, Inc., a recently organized affiliate of Chicago Bridge & Iron Company and the Buckeye Pipe Line Company. Warren has been associated with Chicago Bridge & Iron Company for 10 years and was most recently a contracting engineer in the Philadelphia sales office of that firm.

T. J. Maitland, electrolysis and protection engineer with American Telephone & Telegraph Company's long line department, has been appointed chairman of the technical practices committee of the National Association of Corrosion Engineers, succeeding **E. C. Greco,** United Gas Corporation, who has been chairman for the past two years. Maitland, active in NACE since 1944, is chairman of the association's technical unit committee T-2B on anodes for impressed currents, technical unit committee T-4B on corrosion of cable sheaths and task group T-4B-1 on lead and other metallic sheaths. NACE also announces three new directors: **T. R. B. Watson,** founder of Corrosion Services Ltd., representing the Canadian Region; **J. C. Spalding,** Sun Oil Company, the South Central Region; and **E. F. Moorman,** International Harvester Company, the North Central Region.

L. D. Fraser, director of Imperial Oil Ltd., has been elected a director of Trans Mountain Oil Pipe Line Company to fill the vacancy on the board created by the resignation of **J. K. Jamieson,** president of International Petroleum Company, Ltd.

A. Carl Gladden was elected executive vice president as well as treasurer of Texas Gas Corporation and Texas Gas Pipe Line Corporation at recent annual meetings of stockholders and boards of directors, and **John L. Buvens,** vice president in charge of gas supply and sales, was added to the boards of directors of both companies. Re-elected directors and officers include: **Herbert R. Eldridge; Charles H. Jagow; George P. Jenkins; H. Hugh McConnell; Dr. George G. Oberfell; Russell M. Riggins,** president; **P. W. Riggins,** vice president; **Dr. Willard Dow,** vice president; **A. A. White,** vice president, general counsel and secretary; **Homer H. Martin,** controller and assistant secretary; and **Earl D. Elliott,** assistant secretary.

Glenn H. Willis has been named manager, crude oil supply and transportation for Clark Oil & Refining Corporation, according to **Earl Lamm,** vice president in charge of the Dallas office.

E. William Glanton has been appointed purchasing agent of The Buckeye Pipe Line Company and its wholly-owned subsidiaries, Northern Pipe Line Company and New York Transit Company, Inc. Glanton has been associated with Buckeye since 1944 and, after five years as general foreman of the Indiana Truck Line Division, came to the New York office in 1956 as assistant personnel director.

William R. Connole, commissioner, has been elected by the Federal Power Commission to serve as its vice chairman for the calendar year 1959, succeeding Commissioner **Frederick Stueck** who has served as vice chairman for the last two years.

H. W. Collins has been named to head Aurora Gasoline Company's crude oil supply, procurement and transportation and pipeline operations, **Max M. Fisher,** chairman of the board, has announced. Collins also will continue as manager of marine properties and vice president and manager of Michigan Tankers, Inc., an Aurora subsidiary. **W. C. Gleich,** who will continue as manager of crude oil supply, will assist Collins in the terminal, pipeline and marine operations.

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New Power Unit Prevents Microwave Interruptions

A new inverter power unit, designed specifically to operate in conjunction with an Onan emergency electric plant and an Onan automatic line transfer control, but adaptable to existing standby equipment in microwave installations, is announced. The transistorized inverter can take over any power load up to 5 kva within .008 to .028 seconds depending on what part of the a-c line cycle that the power interruption occurs. A fast acting transfer relay switches the microwave radio equipment from the inactive power line to the inverter. The entire unit is mounted in a steel cabinet. *D. W. Onan & Sons, Inc.*

Circle number (81) on reply card.

Gas Flow Computing "Package" Systems

Gas flow computers which provide continuous, up-to-the-minute flow data for gas dispatching have been announced. They solve the flow equation and provide a chart record of corrected flow (Q). Correction for gas temperature is automatic. Corrections for supercompressibility and specific gravity factors can be manually set. The basic systems include units for single meter run and multiple meter run stations, or combinations of these. Each system is a complete cabinet or panel mounted "package" — piped, wired, and calibrated under simulated operating conditions. The systems are recommended for installation at the metering station rather than the main office so that only one computed value need be telemetered to the dispatcher. This method saves transmission line space and cost as well as main office space. *The Foxboro Company.*

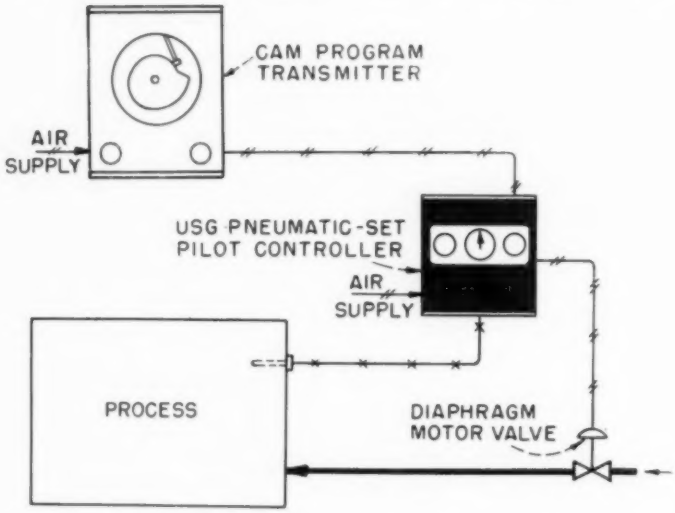
Circle number (82) on reply card.

Message Relay Set

A new automatic message relay set has been introduced. It is the Model 28 RT (reperforator transmitter-distributor)—a high capacity, self-contained punched tape message relaying facility for receiving wire signals at speeds ranging from 60 to 200 wpm, converting them into perforations in paper tape and transmitting them at the same or another speed to local or remote receiving stations. It is designed for a variety of uses in communications, data processing and automation. *Teletype Corporation.*

Circle number (83) on reply card.

Pilot Controller Has Pneumatic Set Point Adjustment



A pneumatic adjustment makes it possible to position a pilot controller by a 3 to 15 psi signal so the controller may be located remotely and adjusted from a central control panel. It is also useful for "cascade control," with a primary controller pneumatically adjusting the set point of a secondary controller for closer control of pressure, temperature, flow, etc. The indicating controller can be mounted directly on the diaphragm motor valve it operates. Adjustable mechanical stops set minimum and maximum travel of the control index. By these same adjustments, the pneumatic setting signal can be "over ridden" to position the control index manually at any point of scale.

The diagram shows a typical program control system using the pneumatic-set controller. A programmed signal such as that obtained from a cam program transmitter is sent to the controller in accordance with a predetermined schedule cut on a plastic cam. For example, temperature in a vessel can be raised at a desired rate to a "holding" temperature, maintained at that value for a certain time, and then perhaps lowered at another rate. *U.S. Gauge Div., American Machine & Metals, Inc.*

Circle number (84) on reply card.

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New BS&W Monitor For LACT Systems

Capalarm is a new BS&W monitor, watchdog for excessive water in LACT systems. Explosion-proof, weatherproof, operating from external power or battery, and essentially unaffected by temperature changes, Capalarm automatically diverts oil for retreating when it is contaminated in excess of specifications. It is suitable for other applications where capacitance varies enough to indicate off-normal product conditions. Accuracy is said to be better than 1/10 of 1 percent water content. The unit is available in a wide variety of ranges, probes, and time delays. *Fischer & Porter Company.*

Circle number (85) on reply card.

Preset Counter-Timer

A new, universal counter and timer with 20 channels of preset high-low limits has been introduced for applications where it is necessary to monitor and alarm frequency or time interval measurements. The model 5690-80 preset counter and timer is capable of measuring frequency of a sine wave input from 10 to 1,000,000 cps, and time intervals in milliseconds from 1 to 99,999. *Beckman Systems Division.*

Circle number (86) on reply card.

"Jeweled" Escapement For Timing Devices

A "jeweled" escapement is now available with all Rockwell Manufacturing Company's 31-day chart drives used for driving recording charts — particularly pressure flow and temperature recorders — of 7 to 31-day rotation. The escapement has 7 jewels: 4 at the chart drive's balance wheel pivots, 1 on the balance wheel roller pin and 2 on the verges of the pallet fork. The major function of a clock escapement — accurately controlling the release of power — is provided by the hard jewel surfaces which limit friction or wear to a minimum. The even release of the chart drive's mainspring power results in accurate time measurement. *Rockwell Manufacturing Company.*

Circle number (87) on reply card.

New Plastic Microphone For Two-Way Radios

A new lightweight, plastic microphone is now standard equipment with all General Electric Progress Line mobile two-way radio units, replacing conventional metal types. Built to withstand extreme conditions of vibration and corrosion, according to the manufacturer, the new mike uses a controlled magnetic cartridge. *General Electric.*

Circle number (88) on reply card.

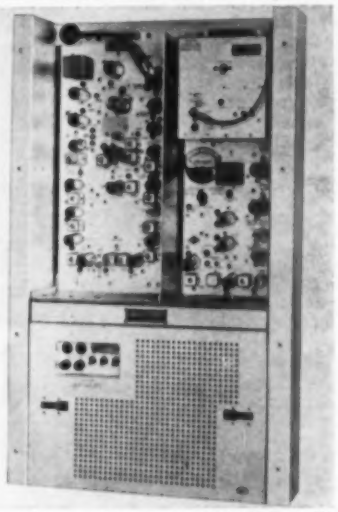
Large Panel Meters

D-c linearity within one percent of full scale is standard in a new line of 6-in. panel meters. The model 661 has a wide scale arc of 5½ in. Sensitivities of this model are the same as those of the manufacturer's smaller panel meters, beginning with 0 to 5 microamp or 0 to 5 mv. Minimum practical response time is about 100 millisec. Both d-c and a-c models are available. *Assembly Products, Inc.*

Circle number (89) on reply card.

FM Radio Terminal

For pipeline communications, control, and data processing — as well as constant contact with offshore or other separated



operations — this Type 896 FM radio terminal can handle up to 6 simultaneous toll-quality conversations from suitable multiplex equipment or may be used for multiple data processing with or without voice channels. The 35-in. high, 110-lb enclosure includes receiver, transmitter, and power supply. Frequency range is normally 148-174 mc. *Radio Engineering Laboratories, Inc.*

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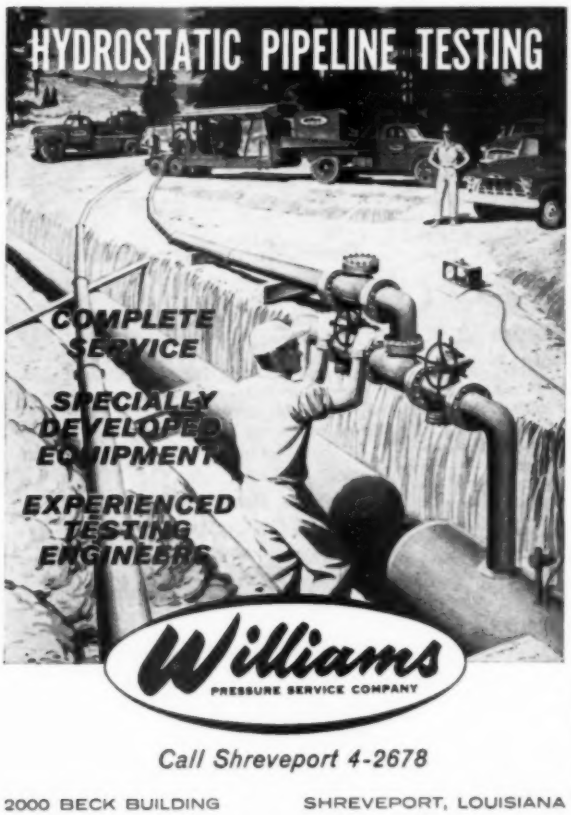

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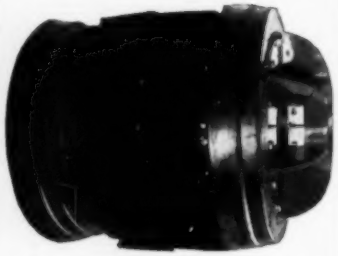

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Control Switch Data

Instrument and control switches—used in conjunction with circuit breakers, transformer tap changers, motor-operated rheostats, instruments, and many other types of electrically controlled apparatus — are described in a new illustrated bulletin. The Standard 210 are available as either maintained or spring return contact types, are rated for 20 amp continuous capacity with 600-v insulation, are designed for panel mounting, and are furnished with a choice of handles. *Allis-Chalmers Manufacturing Company.*

Circle number (91) on reply card.

Microwave Line Data

A new bulletin describes General Electric's new 6 kmc microwave line. The equipment is described as featuring capacity up to 120 channels, time or frequency division multiplexing, passive bridging, plug-in units, and Klystron tubes. The bulletin explains the frequency bands in which the equipment may be used, dimensions of basic terminals, power consumption and other nominal specifications. *General Electric.*

Circle number (92) on reply card.

Self-Loading Floats, Low Bed Trailers

Three models of Dorsey Trailers' self-loading floats are described in a bulletin. They are: The Hoft-187, designed for rugged hauling requirements, providing a payload capacity of 80,000 lb evenly distributed and up to 50,000 lb concentrated in 10 ft; Moft-187, 60,000 lb payload capacity evenly distributed and as much as 41,000 lb concentrated in 10 ft; and Loft-187, which hauls 45,000 lb evenly distributed and up to 25,000 lb concentrated in 10 ft. Simple loading instructions are outlined. Another bulletin gives specifications of the company's Model "MK" 10-ton and 15-ton low bed heavy duty semi and full trailers. *Dorsey Trailers.*

Circle number (93) on reply card.

New Clutch Is Feature Of Backfiller Bulletin

The new water-cooled throw-out clutch of the Cleveland 190 backfiller is described in a 6-page color folder. The clutch is said to prevent overheating, provide accurate day-long continuous casting control, maintain proper clutch adjustment, and add to the work life of the clutch components. Described also is another major improvement—the repositioning of the boom hinges above the crawler tracks to keep them free of mud, muck and water. *The Cleveland Trencher Co.*

Circle number (94) on reply card.

Technical Guidance In Welding Catalog

"Welding Guide and Catalog" is a 32-page, pocket-size service-type catalog-manual designed to aid the welder in careful selection and better use of welding electrodes and rods. All products are given in chart form, together with specific information. Pertinent information includes such facts as welding applications, AWS-ASTM designations, heat treatment data for maximum properties, pre-heating data, and tensile properties. Technical guidance on successful welding performance is given in a section entitled "How to Get Better Stainless Steel Welds" and by a chart on "Effect of Alloying Elements on Weld Metal Properties." *Arcos Corporation.*

Circle number (95) on reply card.

Temperature Controls

Thermoswitch controls and mounting wells are described in a new 8-page booklet. In addition to describing how the units operate on the differential expansion of metals, complete operating specifications and dimensions and available modifications and special features are included. *Fenwal Incorporated.*

Circle number (96) on reply card.

"Packaged" Control Units

A new 4-page bulletin describes "packaged" centralized control systems. Bulletin 159 illustrates various custom-engineered control panels which combine a wide range of sequencing, supervising, indicating and power controls for various applications. *Protection Controls, Inc.*

Circle number (97) on reply card.

"O" Ring Design, Uses

A new bulletin, dealing with the design and application of "O" rings, has just been published. The 20-page booklet discusses materials of construction, dynamic and static applications, use of back-up or non-extrusion rings, and groove design for this style of packing. *The Garlock Packing Company.*

Circle number (98) on reply card.

Gas Odorization Manual

Principles of gas odorization, soil penetration, installation and maintenance of odorizing equipment, and determination of odorization efficiency highlight a new odorization manual published by Natural Gas Odorizing, Inc. Specifications also are discussed, as well as reasons for different type odorants and the chemistry of gas odorants. *Natural Gas Odorizing, Inc.*

Circle number (99) on reply card.

Engine Reconditioning Hints Given In Booklet

What is the proper way of obtaining positive initial valve seating when reconditioning a diesel engine? What is the maximum clearance allowable between a remachined top groove and a new "wide" top piston ring? What is the maximum diameter wear limit for a cylinder liner before it must be replaced? The 8-page booklet, "Money Saving Hints On Engine Reconditioning," presents Caterpillar's answer to these questions, with tips on various operations necessary in reconditioning engines. *Caterpillar Tractor Co.*

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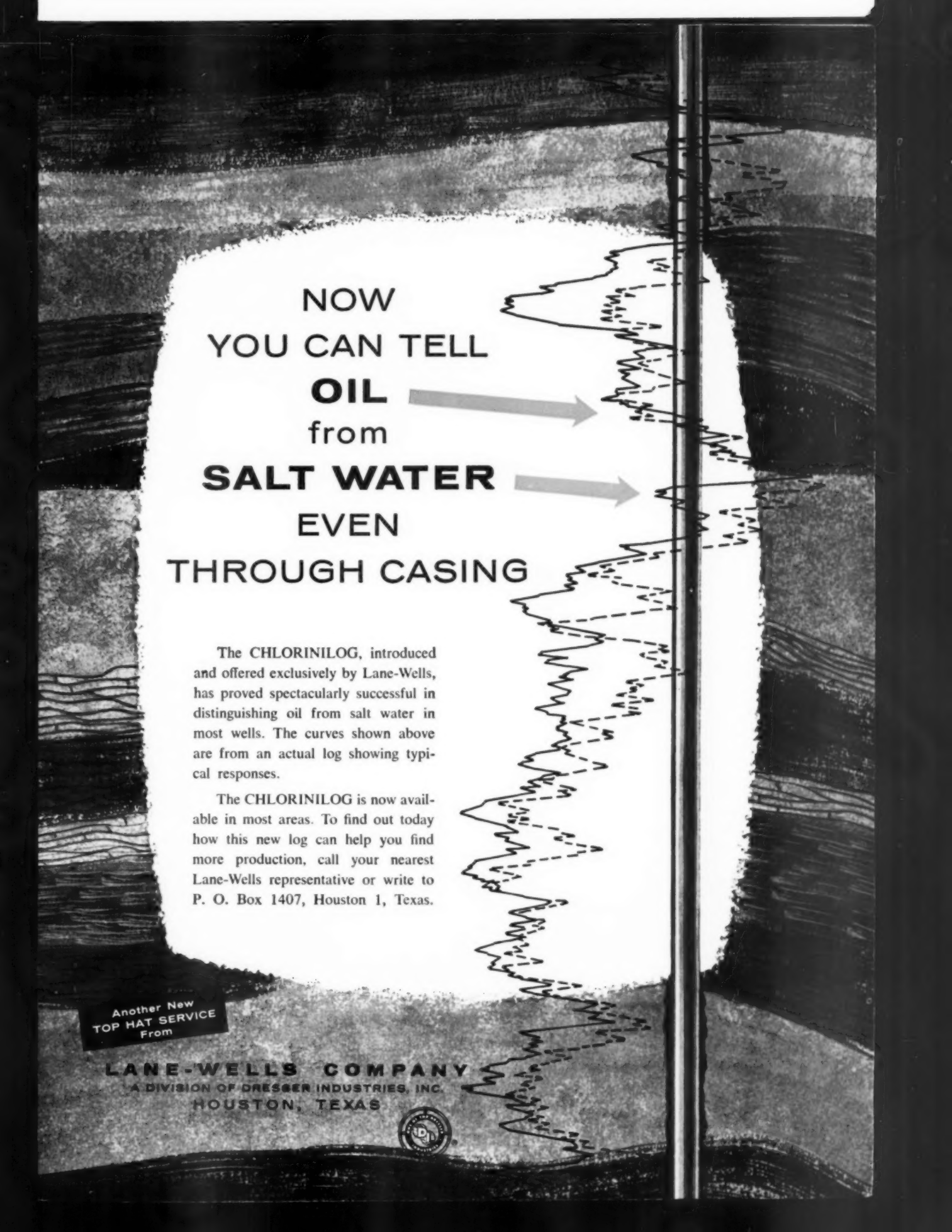
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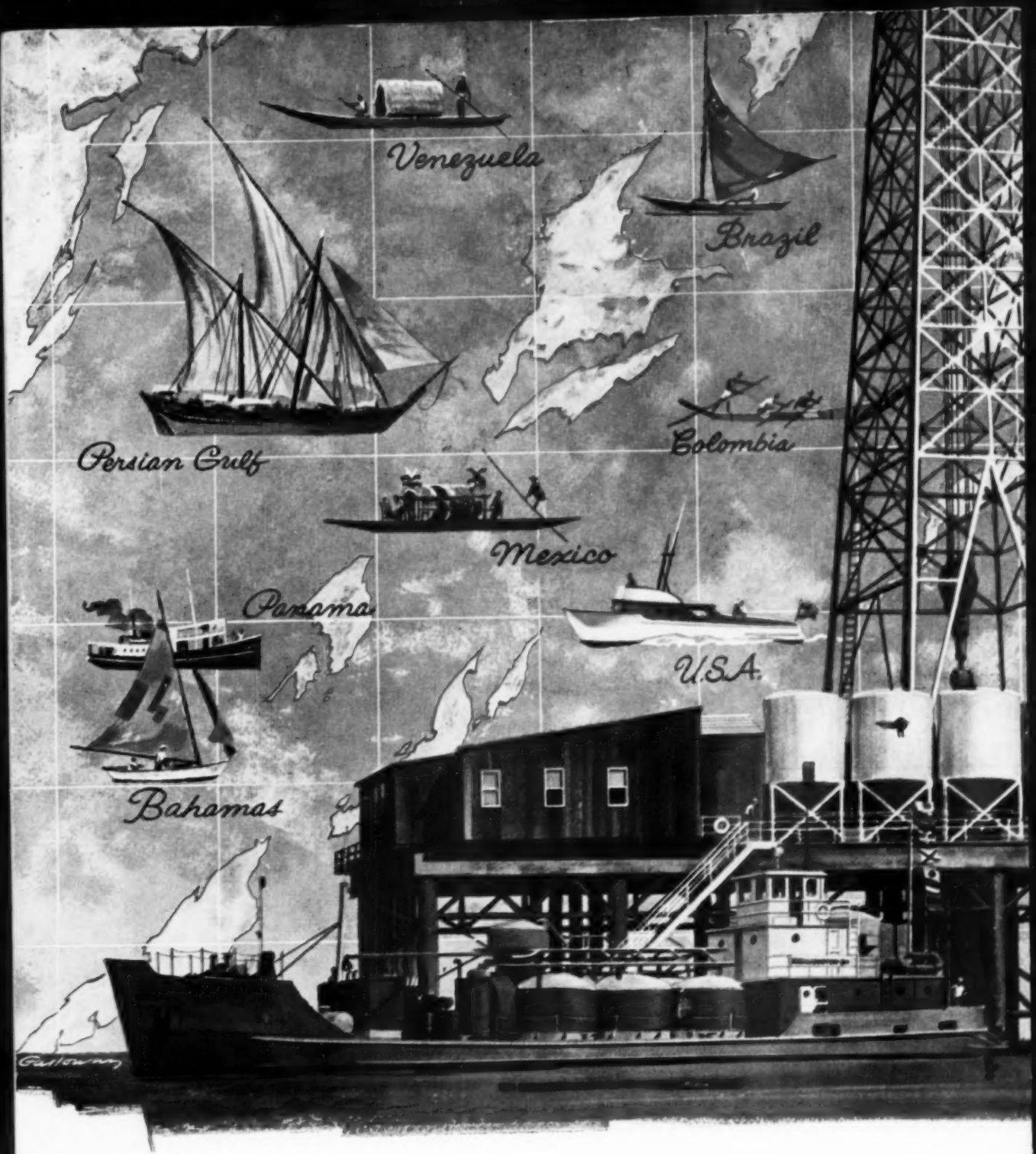

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